edited by
Rossella Bardazzi
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Macroeconomic modelling for policy analysis

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R. Bardazzi
L. Ghezzi

Introduction

INFORUM[1] (Interindustry Forecasting Project at the University of Maryland) is a research project started forty-five years ago by Clopper Almon, now Professor Emeritus at the University. The focus is on the development of dynamic, interindustry, macroeconometric models to forecast the economy behaviour in the long run.

Over the last decades, the INFORUM approach to model building has been shared by economists in many different countries. Researchers have focussed much of their efforts in developing a linked system of international interindustry models with a consistent methodology. A world-wide network of research associates use the same methods and software obtaining comparable results. INFORUM partners have shared their researches in annual conferences since 1993. The XXth INFORUM World Conference was held in Florence in September 2012 and this volume contains a selection of works presented during the sessions. All these contributions share an empirical and pragmatic orientation that is very useful for policymakers, stakeholders, and applied economists. Some papers are devoted to specific topics (total factor productivity, energy issues, external linkages, demographic changes) and some others are oriented to model building and simulations.

A special role in this volume is devoted to a key topic in economics, especially prominent during the recent international crisis, that is strictly interconnected with the economic development in the long run: the analysis of factor productivity. The paper by Meade is aimed at designing a comprehensive and internally consistent modelling framework for 'mul-

[1] www.inforum.umd.edu.

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tifactor productivity'. This modelling framework is integrated within the INFORUM model of the U.S. economy which forecasts output, hours worked, investment, capital stocks and intermediate purchases in current and constant prices. The Multi-Factor Productivity model presented is a useful tool for understanding productivity growth of the U.S. economy in a consistent and comprehensive way.

All other contributions are collected into two sections. The first one contains some works focused on new models and software development. As already mentioned, INFORUM models share a common structure and, moreover, a common software, InterDyme, originally developed by Almon. Model builders not only must have a deep knowledge of economic theory but they must also get acquainted with software packages and programming languages. 'PortableDyme' is a development of the original INFORUM software presented by Großmann, Hohmann and Wiebe which is aimed at making the model building process easier, especially for beginners. Tomaszewicz and Trębska build a new dataset for the Polish economy by including the flow of funds accounts into the Social Accounting Matrix and they apply IO techniques to this new set of integrated information. A comparative analysis of results for Poland with other European countries is provided as well. Household consumption is studied by Ghezzi within a new multiregional modelling framework for Italy, the Dante model. The strategy to model private consumption consists into two blocks: the first one, at the aggregate level, is based on the Life Cycle Hypothesis and it is used to obtain the total of resident consumption detailed at the regional level; the second one is a system of equations to produce an estimation of price and income elasticities for many different items at the national level. This system of equation is named PADS (Perhaps Adequate Demand System) and it has been applied by several INFORUM models. A multiregional model for Italy (MRIO) has been developed also in the work by Cherubini and Paniccià, MRIO). Important methodological improvements in this work concern the multiregional trade flows estimate procedure, thanks to the availability of unique survey data produced by Banca d'Italia. The model is used to investigate changes of the Italian economic and productive structure at a sub-national level in the 1995-2006 period, with a special focus on the role of spatial interdependencies among regions in the transmission of shocks. Two specific issues are studied by the remaining papers of this session. Werling and Horst investigate the effects of defense spending cuts on the US economy using the LIFT model. The analysis is conducted to determine the economic and employment impacts of specific alternative scenarios for federal defense spending cuts from 2012 to 2022 considering the effects on the U.S. economy as a whole, on the industrial composition of the country, and the effects on each state. Finally, a medium term forecast of the Russian economy is developed by Baranov, Gilmundinov, Pavlov and

Tagaeva. The authors use a Dynamic input-output model disaggregated for 64 industries and present forecasts for the period 2012-2015.

The second section of the volume is devoted to special issues analyzed using a national perspective. The role of external linkages is very important for a 'small economy' and it is studied in the paper by Josef Richter considering the role of tourism in the Austrian case, while the development of trade patterns is explored by Ozolina and Auzina focusing on the Baltic Republics. These analyses made it very clear that to investigate these issues at the macro level gives a very limited perspective of the overall effects. The implications at the level of industries and product groups are much more relevant and deserve special attention. A role in the long run growth is for demography: two contributions included in the book study in depth the impact of demographic changes for large and rapid-growing economies such as China and Russia. For the first country Li, He and Ni analyze the consequences on consumption patterns given by the changing age structure of the Chinese population. Furthermore, an I/0 model is used to study the impact of demographic structural change on the economic and employment structure with a comparative static perspective. The paper by Vadim Potapenko focuses on the problem of financing the pension system in Russia. A simulation of increasing social security contributions to support the growing pension payments given by population ageing is presented by the author. Another issue we must pay attention in the simulation of the real economy is the evolution of the energy sector. The selection of papers included in this volume contains two works on this subject with different perspectives. The main focus of the paper presented by Mullins, Viljoen and Mosaka is on the analysis and forecasting of the petroleum sector in South-Africa. The The South African Forecasting Inter-Industry Model (SAFRIM) is used to study the evolution of demand for petroleum products and its impact on the rest of the economy. Finally, shale gas resources in Poland are investigated in the work by Plich. Unconventional gas resources may have significant importance for the national balance of energy and open up new opportunities for Poland. Costs and benefits of the exploitation of these new resources are described in the paper.

This collection of works follows several other publications of the INFORUM group in the last decades. It is a further testimony that the project founded in 1967 by Clopper Almon is well and alive, producing new empirical researches and contributing to the debate on several crucial issues for economic systems all over the world.

D. S. Meade

Multifactor Productivity Measurement and Forecasting in the Inforum LIFT Model

The indicated importance of productivity increase may be taken to be some sort of measure of our ignorance
Moses Abramovitz (1956)

This paper will describe some exciting new developments in the Inforum *LIFT* model of the U.S. The model is grounded in a new set of detailed annual input-output tables, derived by Inforum from U.S. data published by the Bureau of Economic Analysis (BEA). This set of tables brings us closer to the goal of developing an integrated model of multifactor productivity, which is consistent at the industry and aggregate level.

Since economists first started to develop economic statistics and national accounts, a motivating principal has been to measure the growth of the economy, and discover its sources. Classical economists such as Smith, Ricardo and Mill had observed that more output could be produced with a given quantity of labor by employing machinery and other capital. But it wasn't until the 1920s that comparable measures of labor and output became available, and the first estimates of labor productivity growth appeared[1]. By the 1950s, the concept of the production function became formalized, and the idea of segregating growth in output per head into technical change and the availability of capital per head caught on, especially after Solow's (1957) introduction of the aggregate production function. Solow's work stimulated numerous studies relating real value added growth to real capital and labor inputs, and deriving the residual as a measure of technical change and other factors.

At the industry level, dissatisfaction with the real value added concept stimulated the desire for a comprehensive measure of productivity that would relate real gross output to capital, labor and intermediate inputs.

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[1] The productivity program at the U.S. Bureau of Labor Statistics (BLS) is actually older than the U.S. National Accounts, and BLS pioneered the measurement of output and employment at the industry level. See Dean and Harper (2001).

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A convenient classification of intermediate inputs into the categories of energy, materials and services led to KLEMS (capital, labor, energy, materials and services) databases and productivity studies. In either case, KL or KLEMS, the resulting measure of productivity is called multifactor productivity (MFP) defined as

$$MFP = \frac{Q}{I} \tag{1}$$

where Q is real gross output, and I is a suitably defined aggregate of real inputs.

Since June 2004, the U.S. Bureau of Economic Analysis has been developing and improving a time series of annual input-output (IO) tables, with 65 industries[2]. A satellite account is the BEA KLEMS dataset, which apportions intermediate inputs to energy, materials or services[3].

A new version of the Inforum *LIFT* model has been developed, which is based on the 2002 benchmark IO table and the time series of annual IO tables. All industry data in the new *LIFT* model is on the same sectoral basis. These data include output, employment, investment, capital stocks and value added components. As described below, a KLEMS dataset has also been incorporated into *LIFT*, with the goal of dynamically forecasting industry and aggregate MFP. The list of industry sectors and their definitions in terms of the 2002 North American Industry Classification System (NAICS) are shown in Appendix A.

The first part of this paper will discuss the background of MFP development in the U.S. and its current status. The second part will describe the incorporation of an MFP module within the *LIFT* model, and present some historical and forecasted results. The conclusion will evaluate the worthiness of our exercise and chart some directions for extending and improving this work.

MFP: A Curriculum Vitae[4]

A Productivity Index

The measure of output per unit of input is more easily considered if we ignore intermediate inputs for a moment, and write

$$pQ = wL + rK \tag{2}$$

[2] Moyer *et. al.* (2004) describes the first release of this series, which was then based on a modified version of the U.S. 1997 Benchmark IO table. The most current release, described in Gilmore *et. al.* (2011) includes tables from 1998 to 2010.
[3] First described in Strassner *et. al.* (2005) and now also available from 1998 to 2010.
[4] For a fuller biography, see Hulten (2001). This section owes a debt to that paper and to Griliches (1996).

where p is the price of output, w is the wage of labor, and r is the cost of capital. If we deflate to a base year, say $t = 0$, we need to use a scaling factor S to bring both sides into equality:

$$p_0 Q_t = S_t[w_0 L_t + r_0 K_t] \tag{3}$$

The variable S can be viewed as an index of output over input. This method of measuring productivity was mentioned by Copeland (1937), and later implemented by Stigler (1947). Note that this index is basically a type of Laspeyres index since it uses base period quantity weights. Its growth rate over time is sensitive to the choice of the base period.

Production Functions, Sources of Growth and the "Residual"

Solow began the study of productivity using a production function with a shift parameter:

$$Q_t = A_t F(K_t, L_t)] \tag{4}$$

The shift parameter A was identified by Solow with technical change, although it includes many other factors. It is related to the scaling factor S described above, but is a more general indicator of output per unit of input, or MFP. Without imposing a specific form on the production function F, but making a few assumptions, we can derive an expression for the growth of A over time.

First, logarithmically differentiate the production function (4):

$$\frac{\dot{Q}_t}{Q_t} = \frac{\partial Q}{\partial K}\frac{K_t}{Q_t}\frac{\dot{K}_t}{K_t} + \frac{\partial Q}{\partial L}\frac{L_t}{Q_t}\frac{\dot{L}_t}{L_t} + \frac{\dot{A}_t}{A_t} \tag{5}$$

If each input is paid the value of its marginal product:

$$\frac{\partial Q}{\partial K} = \frac{r_t}{p_t} \quad and \quad \frac{\partial Q}{\partial L} = \frac{w_t}{p_t} \tag{6}$$

then we can write the unobserved output elasticities as income shares s:

$$\Re_t = \frac{\dot{A}_t}{A_t} = \frac{\dot{Q}_t}{Q_t} - s_t^K \frac{\dot{K}_t}{K_t} - s_t^L \frac{\dot{L}_t}{L_t} \tag{7}$$

The total differential is the Solow residual, or the growth in output not explained by the growth in inputs. Like S, it is an index number for MFP that can be calculated from prices and quantities.

Equation (7) can be rearranged to show the relationship of the growth of labor productivity to the growth of MFP and the change in the capital-labor ratio. If we write Q/L as q, and K/L as k, then

$$\frac{\dot{q}_t}{q_t} = \frac{\dot{A}_t}{A_t} + s_t^K \frac{\dot{k}_t}{k_t} \tag{8}$$

The growth of labor productivity is the growth in MFP plus capital's share times the growth in the capital-labor ratio.

MFP in the Input-Output Framework

In most of the analyses based on the above approach, the measure of real output Q used is real value added, usually obtained by double deflation. This may be done with fixed weights, where deflated intermediates are subtracted from deflated output, or using a chain index approach as is done by the BEA in the U.S. However various researchers have found a production model for real value added to be implausible[5]. Real value added is not a measure of output, but is rather a hybrid of output less some inputs.

If data are available, a measure of real gross output can be related to labor, capital and aggregates of intermediate inputs. An ideal dataset is a time series of IO tables in current and constant prices, along with estimates of labor and capital input and cost shares[6]. If intermediate goods are classified as energy (E), materials (M) or services (S), the production function can be specified as:

$$Q_t = A_t F(K_t, L_t, E_t, M_t, S_t)] \qquad (9)$$

where now Q is real gross output (not real value added) and the corresponding MFP estimate is derived similarly to (7)

$$\Re_t = \frac{\dot{A}_t}{A_t} = \frac{\dot{Q}_t}{Q_t} - s_t^K \frac{\dot{K}_t}{K_t} - s_t^L \frac{\dot{L}_t}{L_t} - s_t^E \frac{\dot{E}_t}{E_t} - s_t^M \frac{\dot{M}_t}{M_t} - s_t^S \frac{\dot{S}_t}{S_t} \qquad (10)$$

The intermediate value share weights are derived from the nominal IO tables. The cost share for labor is the labor compensation over total nominal gross output. The capital share is derived as the remainder. The intermediate inputs are derived from a time series of constant price input-output tables.

When using discrete, annual data, it is common to estimate (10) using a Tornqvist index, in which the rate of change in each variable is approximated by the differences in logarithms, and the shares are the average of the current period share and the lagged share.

Domar (1961) showed that industry and aggregate productivity growth can be related using a set of ratios that sum to more than 1. Each industry share is derived as the industry nominal gross output divided by the sum of value added (GDP) in all industries. This means that intermediate transactions contribute to aggregate productivity by allowing productivity gains in successive industries to augment one another.

[5] Jorgenson, Gollop and Fraumeini (1987) perform tests on the existence of a value added function and reject the hypothesis in 40 of 45 industries analysed. The existence of a K-L aggregate, necessary for a measure of K-L productivity has also been explored by several investigators and rejected. Meade (2007) discusses the history and problems with the real value added concept, and shows several examples of how the derivation of real value added can lead to questionable results.

[6] Gullickson and Harper (1999, unpublished, I can furnish on request) discuss the characteristics of the ideal IO dataset and the method of aggregating to the all economy MFP using the Domar (1961) aggregation technique.

The Measurement of Capital

Measurement problems abound for all components of the MFP calculation. For example, in many industries, the proper calculation of output price, and therefore real output, may be based on indirect information or on theoretically derived measures of quality. However, the question of the measurement of capital has filled the equivalent of hundreds of books, and so deserves a word.

Ideally, it is not the "quantity" of capital, as measured by real capital stock, that should be important, but rather the *flow of services* provided by capital goods[7]. Since this flow of capital services is not directly observable, in practice we must make use of estimated stocks and assume that the flow is related to that stock. If we have no detail on the composition of the stock by asset type, then the stock/flow distinction is not relevant. However, if stock information is maintained by industry and asset type, then we can make use of the different service lives of different assets to derive weights to estimate the total capital service flow by industry. The essential idea is that since some assets depreciate quickly (computers) and others depreciate slowly (buildings), the contribution to service flow should reflect this. The service flow idea is related to the concept of how much capital is "used up" each period in producing output. This idea is also related to the user cost of capital, which is defined as the total cost (interest, depreciation and revaluation adjusted by tax incidence) of using a unit of capital for a definite period, such as a year.

A Short Review of Published Data for the U.S.

The Bureau of Labor Statistics (BLS) multifactor productivity program has taken the lead in measuring both labor productivity and MFP at the industry and aggregate level. BLS produces two periodic releases: The Major Sector Productivity program publishes annual measures of output per unit of combined inputs for the private business, private nonfarm business, and manufacturing sectors and for 18 NAICS 3-digit manufacturing industries. The aggregate business measures are real value added per combined unit of labor and capital input. The industry measures are derived using the KLEMS method. These are published by BLS annually in "Multifactor Productivity Trends in Manufacturing"[8]. The Industry Productivity program publishes annual measures of output per unit of combined inputs for 86 4-digit NAICS manufacturing industries, the air transportation industry,

[7] BLS (1983, Appendix C) and Harper (1999) discuss the capital measurement within the BLS MFP program. Jorgenson, Gollop and Fraumeini (1987) describe an ambitious attempt to measure capital service flows by industry.
[8] The latest release can be found at http://www.bls.gov/news.release/pdf/prod5.pdf, published June 2012, with estimates through 2010.

and the line-haul railroad industry. A separate program estimates MFP for nonmanufacturing industries. These estimates are derived using the KLEMS method[9].

As mentioned above, the BEA has been producing a set of "KLEMS" accounts since June 2005[10]. These data are derived from the detailed database underlying the annual IO tables and GDP by industry. The intermediate data is divided into energy, materials and services, and show total nominal cost, chained quantity indexes and chained price indexes for each major component. Detailed intermediate data underlying the estimates is also available. All data are currently published from 1998 to 2010, with an update expected in December 2012. BEA does not publish quantities and costs of labor and capital with this dataset, but the ingredients necessary for constructing these components are available elsewhere within BEA. The GDP by industry database does show total labor compensation and gross operating surplus, which are needed to estimate the labor and capital cost shares by industry.

The BEA Fixed Assets database contains a wealth of information relating to investment and capital stocks[11]. The Fixed Assets tables present detailed estimates of net stocks, depreciation, and investment by type and by industry (for nonresidential fixed assets only) for private residential and nonresidential fixed assets, and consumer durable goods. Also included are detailed price indexes for nonresidential fixed assets and implied rates of depreciation for selected aggregates by industry. These data are used within BEA to derive depreciation estimates by industry, but are also used by BLS in the MFP program described above.

Incorporation of MFP into the LIFT Model

Overview of LIFT

The *LIFT* model (Long-term Interindustry Forecasting Tool) is the U.S. representative of the INFORUM style interindustry macroeconomic (IM) model[12]. As is typical of this family of models, the *LIFT* model builds up macroeconomic aggregates such as employment, investment, exports, im-

[9] The latest release can be found at http://www.bls.gov/news.release/pdf/prin3.pdf, published September 2011, with estimates through 2009.
[10] Cost, quantity indexes and price indexes for E, M and S are available at http://www.bea.gov/industry/gdpbyind_data.htm, in the link labeled "GDPbyInd_KLEMS_NAICS". Detailed intermediate estimates are available at http://bea.gov/industry/more.htm, in the link labeled "1998-2010 KLEMS Intermediate Use Estimates".
[11] The Fixed Assets data are available at http://www.bea.gov/iTable/index_FA.cfm. The latest data are described in Bennett *et.al.* (2011).
[12] Grassini (2001) portrays the typical features of an INFORUM model. Meade (1999) introduces an earlier version of the current model.

ports and personal consumption from detailed forecasts at the industry or commodity level. This modeling framework is not only applicable to scenario analysis where the interaction of macroeconomic and industry behavior is important, but also for the development of satellite models to study issues such as energy use, greenhouse gas emissions or research and development expenditures[13]. In the current study, we make use of the consistent database of IO tables in current and constant prices, detailed investment and capital stock matrices, and the full set of value added history and forecast in the *LIFT* model to compile historical and projected measures of MFP by industry and for the aggregate economy.

The newest version of *LIFT* is based on the U.S. 2002 Benchmark IO table, and a series of annual IO tables from 1998 to 2010. INFORUM has compiled a time series of estimates of the detailed IO framework at the 399 commodity level, using information from the 2002 Benchmark, the annual IO, and time series of industry output from BEA and commodity imports and exports from the Census Bureau. A new version of the *Iliad* 360 commodity model of the U.S. has been developed based on these same data.

All industry data in *LIFT* is now classified according to the same sectoring scheme, listed in Appendix A, along with the 2002 NAICS concordance. These industry data include employment, hours, labor compensation and other value added components, investment and capital stock, and industry output. The *LIFT* model has 110 commodities, and this is the level of detail maintained for the IO table, final demands and commodity output. The IO quantity and price solutions are calculated at the commodity level. Value added at the industry level is bridged to the commodity level using an industry to commodity value added bridge, and the commodity output solution is converted to industry output using a commodity output proportions matrix.

The typical forecast horizon of *LIFT* is to 2035, although many studies are done with a shorter forecast period. Long-term forecasting for the Medicare Trust Fund Panel is done to 2085, with a slightly modified version of the model. All ingredients necessary to calculate MFP are available through the forecast horizon.

Building KLEMS Accounting into LIFT

There are three main tasks involved into building a KLEMS module into *LIFT*. These are:

- Estimating current and constant price intermediate consumption by industry, divided into energy, materials and purchased services aggregates.

[13] Meade (2009) is an example of using an expanded module for crops and biofuels to study economic impacts of increased ethanol production and use in the U.S.

- Estimating capital stocks by industry for equipment and structures.
- Incorporating *LIFT* data on hours worked, labor compensation and constant and current price output by industry.

Before describing step 1, we should first say a few words about the derivation of the IO database used for the *LIFT* model. This database uses detail from the 2002 Benchmark U.S. IO table and the series of U.S. annual IO tables, combined with detailed data on imports, exports and industry output to create a time series of detailed make and use matrices from 1998 to 2010[14]. These are then converted annually to a product-to-product table, based on commodity technology, as described in Almon (2000). The entire framework is converted to constant prices by deflating output by domestic output deflators, deflating imports by imports deflators, and deflating the rest of each row implicitly in a way that preserves the row sum in constant prices.

In the first step we first convert the recipe matrix derived above in flows to a 110 by 65 use table, using the formula:

$$U = RM' \tag{11}$$

where U is the "new use" matrix described by Almon, and M is the 65 by 110 matrix formed by dividing each cell of the make table by the column total. Once we have obtained this matrix, it is almost straightforward to combine inputs by industry into the energy, materials and services aggregates[15]. Several exceptions to the general classification were made when an energy product was used in the form a material feedstock input, such as natural gas into chemicals or plastic, or where primary fuels were consumed in producing a final energy output, such as the fuels used in electric utilities. Crude petroleum converted to petroleum products is classified as a material input. The U matrix is also deflated to constant dollars and the same aggregates are calculated in constant prices.

Capital stocks for equipment and software investment by industry are derived from the time series of investment by industry in the *LIFT* model. There is still no detailed accounting of structures investment and capital stock by industry. We have derived the structures investment and capital stock keeping an eye on estimates of net stock from the BEA *Fixed Assets* database.

The derivation of the labor component is straightforward, and *LIFT* maintains historical and forecast data on labor hours worked and total la-

[14] There are two versions of the benchmark and annual IO tables produced by BEA. The first version, known as 'Standard' on the BEA website, is *before redefinitions*, where industry output can be easily related to industry data on shipments and inventory change produced by the Economic Census. The second version, known as 'Supplemental', is *after redefinitions*, where certain components of commodity output have been moved from one industry to another to achieve a table closer to a pure product basis. We start with the after redefinitions tables in our work.

[15] 'Energy' commodities in *LIFT* are the following: Crude oil extraction (4), Natural gas extraction (5), Coal mining (6), Electric utilities (10), and Natural gas utilities (11). 'Materials' commodities are 1-3, 7-8, and 15-60. Services are 9,12-14 and 61-104. See Appendix A for the commodity definitions.

bor compensation. Industry output is also calculated by the model, using the *M* matrix described above.

The Tornqvist index formula is used to estimate the growth in the MFP index based on equation (10). The cost shares are estimated as follows:

$$s_{it}^{E} = \frac{EN_{it}}{QN_{it}}, s_{it}^{M} = \frac{MN_{it}}{QN_{it}}, s_{it}^{S} = \frac{SN_{it}}{QN_{it}}, s_{it}^{L} = \frac{LAB_{it}}{QN_{it}}, \quad s_{it}^{K} = 1 - s_{it}^{E} - s_{it}^{M} - s_{it}^{S} - s_{it}^{L} \tag{12}$$

where variables with an 'N' indicate nominal values.

Since the index relies on the growth between two periods, the average share is used:

$$\bar{s}_{it}^{j} = (s_{it}^{j} + s_{i,t-1}^{j})/2 \tag{13}$$

The growth rate (gr) below is calculated as the difference in logarithms:

$$gr(A) = gr(Q) - \bar{s}_{it}^{K} gr(K) - \bar{s}_{it}^{L} gr(L) - \bar{s}_{it}^{E} gr(E) - \bar{s}_{it}^{M} gr(M) - \bar{s}_{it}^{S} gr(S) \tag{14}$$

The index *A* of MFP can then be derived, and is normalized to equal 100 in 2005.

Notable Trends and Stylized Facts

To the best of our knowledge, no one has embodied a set of KLEMS accounts for the U.S. into a dynamic IO model. Although the database underlying *LIFT* is unique, it is based on publically available data. It would be useful to find out how our results compare with others, such as BLS. In this section we elucidate some general industry trends, and see how the MFP calculations from our database compare with the BLS MFP releases for manufacturing.

Table 1 summarizes the composition of gross output derived from the BEA value added data and the Inforum current price IO tables, over the 1998-2010 period. Input cost shares are expressed in percentages, for three major aggregations of industrial sectors. The first section of the table shows the composition for all private industries, the middle section shows the composition for the goods-producing industries, and the third section is for the service industries[16]. Within each industrial grouping, inputs are divided into value added or intermediate inputs.

The period of our data includes a period of strong economic growth in the late 1990s, a slowdown in 2001, and then moderate growth from 2002 to 2007. The period from 2007 to 2010 is a period of slower economic growth, along with declines in commodity prices from 2009 to 2010. Although the

[16] All private industries include 1-61 from table A-1. Goods producing industries are 1-5 and 7-26. Services are 6 and 27-61.

cost shares in the private economy are fairly stable over this period, the share of value added falls from a high of 54.8 percent in 2003 to 52 percent in 2007. The year 2007 is marked by a decline in the share of gross operating surplus to 20.7 percent, but this share has risen to a high point of 22.5 percent by 2010. The share of energy in total output is 1.7 percent in 1998, but reaches as high as 2.3 percent in several years, particularly in periods with relatively high energy prices. The share of purchased services shows a continued upward trend over the period, with only a slight decline from 2008 to 2010.

Table 1 – Components of Gross Output by Major Sector

	1998	2000	2003	2005	2007	2010
All Industries	*100,0*	*100,0*	*100,0*	*100,0*	*100,0*	*100,0*
Value added	54,7	53,4	54,8	52,8	52,0	53,9
Compensation of employees	28,4	28,6	28,7	27,3	27,1	27,2
Taxes on production	4,3	4,0	4,3	4,2	4,2	4,3
Gross operating surplus	22,0	20,8	21,7	21,3	20,7	22,5
Intermediate inputs	45,3	46,6	45,2	47,2	48,0	46,1
Energy	1,7	2,3	1,9	2,3	2,3	2,0
Materials	17,9	17,2	15,7	17,1	17,5	16,1
Purchased services	25,7	27,1	27,7	27,8	28,2	28,0
Private goods-producing Industries	*100,0*	*100,0*	*100,0*	*100,0*	*100,0*	*100,0*
Value added	36,1	34,5	35,5	31,9	30,0	31,1
Compensation of employees	22,3	22,9	23,2	20,6	19,9	19,9
Taxes on production	1,0	0,9	1,2	1,1	1,3	1,6
Gross operating surplus	12,8	10,7	11,1	10,1	8,8	9,6
Intermediate inputs	63,9	65,5	64,5	68,1	70,0	68,9
Energy	2,3	3,1	2,7	3,6	3,4	3,0
Materials	40,0	39,8	38,5	41,3	43,1	42,7
Purchased services	21,6	22,6	23,3	23,3	23,5	23,2
Private services-producing Industries	*100,0*	*100,0*	*100,0*	*100,0*	*100,0*	*100,0*
Value added	64,8	62,9	63,4	62,6	62,2	63,2
Compensation of employees	31,7	31,4	31,2	30,4	30,4	30,1
Taxes on production	6,0	5,6	5,7	5,7	5,6	5,4
Gross operating surplus	27,1	25,9	26,5	26,5	26,3	27,7
Intermediate inputs	35,2	37,1	36,6	37,4	37,8	36,8
Energy	1,4	1,9	1,5	1,8	1,7	1,6
Materials	5,9	5,8	5,5	5,7	5,6	5,3
Purchased services	27,9	29,4	29,7	29,9	30,4	29,9

The distributions of the cost shares between goods- and services-producing industries are strikingly different. The intermediate share of goods industries varies between 63 and 70 percent, with a high of 70 percent in 2007. The intermediate share of the services industries is slightly more than half of that, varying between 35 and 38 percent. The services industries have a higher share of value added to total output. The labor compensation component of value added is larger than that of the goods industries, but the gross operating surplus share is much larger, between 25 and 27 percent, compared to a share of 9 to 13 percent for the goods industries. Finally, within the intermediate component, the goods industries purchase a much larger percentage of both energy and materials inputs, and the services industries purchase a high share of purchased services.

Table 2 shows the underlying data for 6 selected industries in 2010, and brings out the variation we observe between industries at this level. Oil and gas extraction has a fairly high share of gross operating surplus (18.1 percent), since it is a capital intensive industry. Purchased services also account for a high share of the costs (38 percent). However, the share of labor compensation in this industry is small, only 12 percent. Retail trade and hospitals on the other hand, have a much higher share of labor compensation (41.2 and 50.8 percent). Taxes on production and imports (TOPI) are high in Oil and gas (energy taxes), Retail trade (sales taxes) and Accommodations (hotel and sales taxes). In 2010, the Computer and electronics industry actually shows negative gross operating surplus. The overall value added share of output ranges from only 23.7 percent in Chemicals to 69.7 percent in Retail trade. The variation in materials use is also quite striking, from a low of 3.1 percent in Retail trade to 41.3 percent in Chemicals. Computers and electronic products are also quite high, at 33.7 percent.

Table 2 – Components of Gross Output: Selected Industries, 2010

	3 Oil and gas extraction	28 Retail trade	59 Accomodation	15 Chemical products	55 Hospitals, nursing, residential care	21 Computer and electronic products
Total	100,0	100,0	100,0	100,0	100,0	100,0
Value added	*41,4*	*69,7*	*63,7*	*23,7*	*60,8*	*27,6*
Compensation of employees	12,0	41,2	38,1	13,9	50,8	34,3
Taxes on production	11,3	14,9	12,2	1,1	2,1	1,6
Gross operating surplus	18,1	13,6	13,4	8,8	7,8	-8,3
Intermediate inputs	*58,6*	*30,3*	*36,3*	*76,3*	*39,2*	*72,4*
Energy	4,1	1,2	3,0	7,7	1,5	0,6
Materials	16,5	3,1	4,3	41,3	9,2	33,7
Purchased services	38,0	25,9	28,9	27,2	28,5	38,1

The cost shares surveyed in tables 1 and 2 are used in developing the weights (in equation 14) for the growth of each input in the construction of MFP by industry. The other important components in the MFP calculation are the growth rates of outputs and KLEMS inputs by industry. Table 3 summarizes the aggregate sectors output and inputs growth rates over selected periods.

Overall, growth in real private output over the period for all industries was 1.4 percent, but output of goods actually declined over the period at -1.0 percent, while services output increased at 2.5 percent. The sub periods were chosen to highlight the effects of the "dot-com" recession in 2001, and the global slowdown that started in late 2007 or early 2008. Total output growth in the first period, from 1998 to 2001 was 3.1 percent, but goods output declined slightly during this period, whereas service industries grew quite rapidly (4.9 percent). The second period includes the 2001-2002 slowdown, but also the period of rapid growth from 2004 to 2007. Average growth of all output (2.3 percent) is somewhat slower than the first period, with the slowdown occurring mostly in services (2.9%). Manufacturing industries' output increases over this period (1.0 percent). In the period 2007 to 2010, overall growth is negative (-2.0 percent), but the decline is concentrated in manufacturing (-5.4 percent), with services declining by only 0.6 percent.

Table 3 – Aggregate Real Output and KLEMS Real Inputs Average Annual Growth Rates

	1998-2001	2001-2007	2007-2010	1998-2010
All Private Industries				
Output	3,1	2,3	-2,0	1,4
Inputs				
(K) Capital stock	8,2	3,0	-0,4	3,4
(L) Labor hours	0,7	0,8	-2,5	-0,1
(E) Energy	7,4	-4,3	-7,0	-2,2
(M) Materials	-0,8	1,5	-5,2	-0,8
(S) Services	5,5	3,4	-2,2	2,5
Private goods-producing Industries				
Output	-0,3	1,0	-5,4	-1,0
Inputs				
(K) Capital stock	3,0	1,8	-1,2	1,3
(L) Labor hours	-0,8	-0,7	-6,5	-2,2
(E) Energy	4,8	-2,8	-10,5	-3,0
(M) Materials	-1,4	1,7	-6,3	-1,1
(S) Services	2,1	3,1	-5,7	0,6
Private services-producing Industries				
Output	4,9	2,9	-0,6	2,5
Inputs				
(K) Capital stock	11,1	3,5	-0,1	4,4
(L) Labor hours	1,2	1,3	-1,3	0,6
(E) Energy	9,6	-5,5	-3,9	-1,5
(M) Materials	1,5	0,9	-1,9	0,3
(S) Services	6,9	3,5	-1,1	3,2

Table 4 – Chemicals Industry: Real Output, Inputs and Productivity Measures Average Annual Growth Rates

	1998-2001	2001-2007	2007-2010	1998-2010
Output	-0,4	3,4	-6,0	0,1
Inputs				
(K) Capital stock	2,3	0,3	1,7	1,2
(L) Labor hours	-2,0	-1,3	-2,8	-1,9
(E) Energy	2,4	0,9	-7,0	-0,7
(M) Materials	-2,2	4,8	-8,1	-0,4
(S) Services	4,4	5,1	-3,8	2,6
Productivity				
(K) Capital stock	-2,7	3,1	-7,5	-1,1
(L) Labor hours	1,6	4,8	-3,3	1,9
(E) Energy	-2,8	2,5	1,1	0,8
(M) Materials	1,8	-1,3	2,4	0,4
(S) Services	-4,7	-1,6	-2,3	-2,5
Multifactor Productivity	-0,8	0,3	-0,4	-0,2

Table 4 shows some of the underlying information used to calculate MFP for the Chemicals industry (NAICS 325). Real output growth is shown in the top line. The next part of the table shows real KLEMS inputs growth. The bottom section shows productivity in relation to each KLEMS input. For example, the line for Labor hours is the well-known measure of labor productivity growth. Finally, the calculated multifactor productivity is shown as the bottom line of the table.

Real output growth for this industry averaged only 0.1 percent over the period, with a period of faster growth (3.4 percent) from 2001 to 2007. This industry has suffered from the global financial crisis, with a growth rate of -6.0 percent from 2007 to 2010. Labor hours worked has declined throughout the period, but the most rapid decline was also in the 2007-2010 period. Both energy and materials use declined faster than output in the 2007-2010 period. Services inputs also declined (-3.8 percent), though not as fast as output.

Productivity growth with respect to each input component shows a mixed picture. Labor productivity growth averages 1.9 percent over the 1998-2010 period, but labor productivity actually declined between 2007 and 2010. Services productivity declines throughout the period. This could be due to outsourcing, change in output mix (a switch within Chemicals to detailed industries that consume more services, such as Pharmaceuticals), or increased use of R&D and technical services. Materials productivity improves in every sub period except for 2001 to 2007.

The bottom line is multifactor productivity growth, which can be understood as a weighted average of the productivity growth with respect to each KLEMS input. MFP as measured in our framework declines on average during the period, at -0.2 percent, though there is a small increase (0.3 percent) during the 2001-2007 period.

How do our calculations for MFP compare to those of BLS? Table 5 is a comparison of the growth rates of MFP for manufacturing industries between the Inforum and the BLS estimates. This table shows significant and at this point unexplained differences between the two sets of estimates. In the next section, we will discuss some considerations that may affect the estimates, and compare our approach with what we know about the BLS approach.

Table 5 – Comparison of Inforum and BLS MFP for Manufacturing Industries

	Average Growth Rate 1998-2010		
	Inforum	BLS	Correlation
Manufacturing	*0,8*	*1,9*	*0,806*
Nondurables	*0,4*	*0,7*	*0,045*
Food, beverages & tobacco	-0,6	0,2	-0,225
Textiles	2,1	0,7	0,730
Apparel & leather	0,4	3,5	0,170
Paper	1,1	0,2	0,663
Printing	0,9	0,8	0,917
Petroleum & coal	0,8	0,3	-0,381
Chemicals	-0,2	1,0	-0,152
Plastics & rubber	0,3	0,8	0,448
Durables	*1,1*	*2,9*	*0,969*
Wood products	1,1	1,6	0,830
Nonmetallic minerals	0,1	-0,7	0,045
Primary metals	-0,9	0,5	0,196
Fabricated metal products	0,3	0,5	0,398
Machinery	1,4	1,4	0,892
Computers & electronics	2,3	10,5	0,941
Electrical equipment & appliances	1,2	1,0	0,750
Transportation equipment	1,3	0,8	0,667
Furniture	1,6	0,5	0,558
Miscellaneous manufacturing	1,7	2,7	0,917

The growth rate for all manufacturing is lower in the Inforum data, 0.8 percent compared to 1.9 percent of BLS. BLS is only slightly higher for nondurables (0.7 percent compared to 0.4 percent for Inforum), but quite different for durables. The largest difference is for computers and electronics. Inforum does not make use of the hedonic deflator for computers espoused by BEA and BLS, but rather uses a deflator that falls more gradually. The third column of the table shows the simple correlation between the two series. The correlation is actually negative in three industries. For all manufacturing, it is .806, and a surprising .969 for durables. The correlation for nondurables is small, only 0.45. The graphs below in Figure 1 show some example comparisons. Both measures have been indexed to equal 100 in 2005.

Figure 1 – Comparisons of Inforum and BLS MFP Calculations

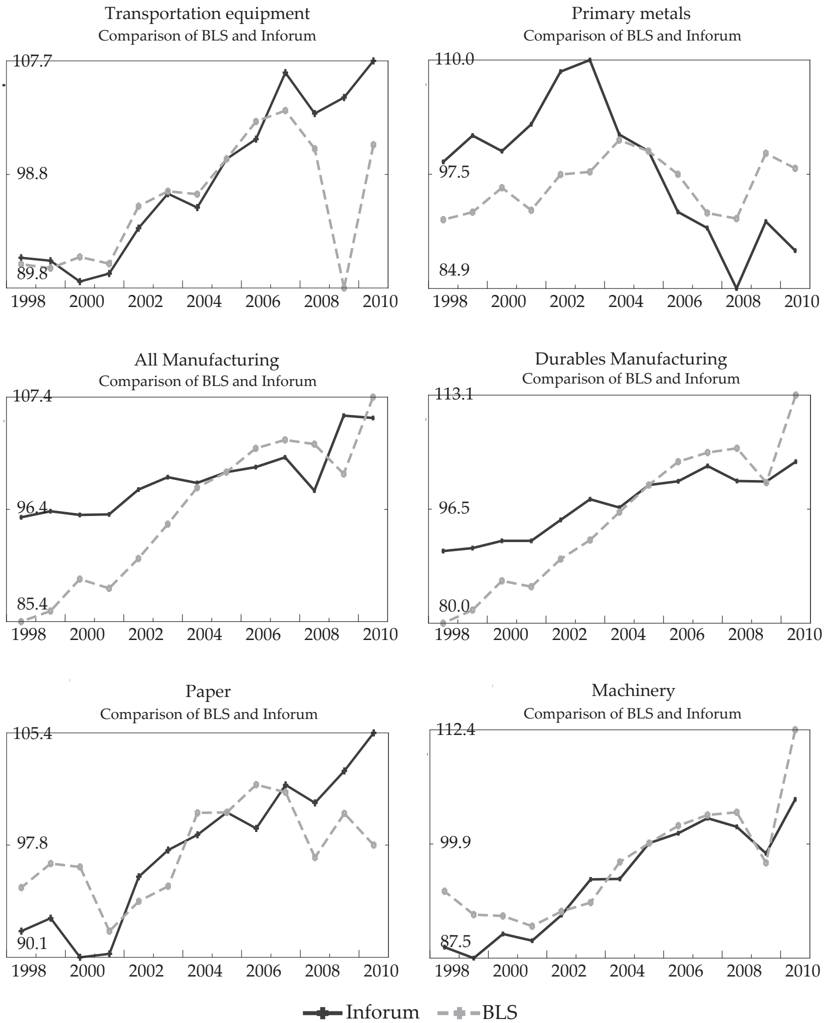
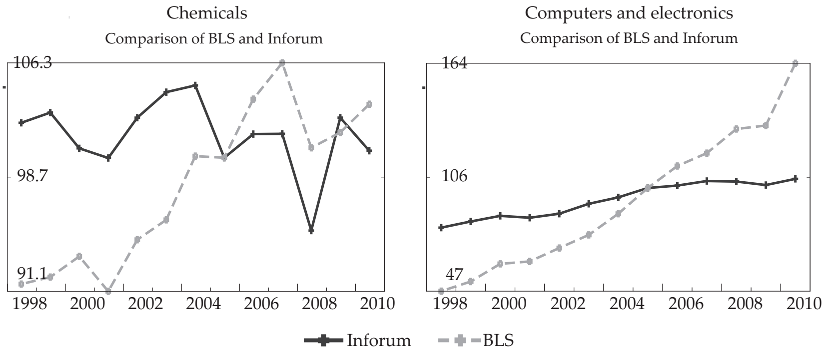


Figure 1 – Comparisons of Inforum and BLS MFP Calculations (continued)



Issues Relating to the Measurement of MFP

Inforum and BLS are both using equation (10) to calculate MFP. Differences in the calculations shown in the tables and graphs above ultimately relate to differences in the measures of output, inputs, or nominal cost shares. We will touch on some of these issues in this section. More information on the compilation of the Inforum data is in Appendix B.

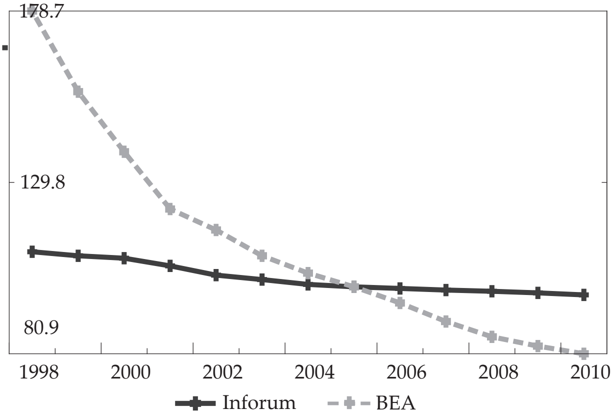
Nominal Output

The Inforum series on nominal output is based on the benchmark IO table, the annual IO tables, and the detailed gross output series published by BEA. BLS constructs its own measures of industry output based on data from the economic censuses and annual surveys from the Bureau of the Census and other sources. BLS also prefers to use a concept known as 'sectoral' output, in which the diagonal component of intermediate has been removed from both output and inputs. Inforum has used gross output, and we have found that removing the diagonal does not affect the growth rate of output substantially.

Output Price

The Inforum output prices are based on those compiled by BEA as part of its gross output series, except that Inforum has chosen not to use the rapidly declining hedonic deflators for Computers (NAICS 334111), Computer storage (334112) and Semiconductors (334413). The Inforum deflator for Computer and electronic products still declines in the period 1998-2010, but not as rapidly as the BEA deflator.

Figure 2 – Computer Deflator



Note that the different treatment of the computer deflator results in slower real growth of computer output, as evidenced by the vastly different growth in MFP between Inforum and BLS shown in table 5. This contributes significantly to the different rate of growth of durable manufacturing MFP as well. Since computers are also an important share of capital equipment investment, the Inforum computer deflator leads to a slower measured growth in real capital stock than BLS or BEA[17]. Using a more slowly growing computer deflator removes some of the apparent contribution to aggregate MFP from the computer industry, and re-allocates that to computer-using industries.

Capital

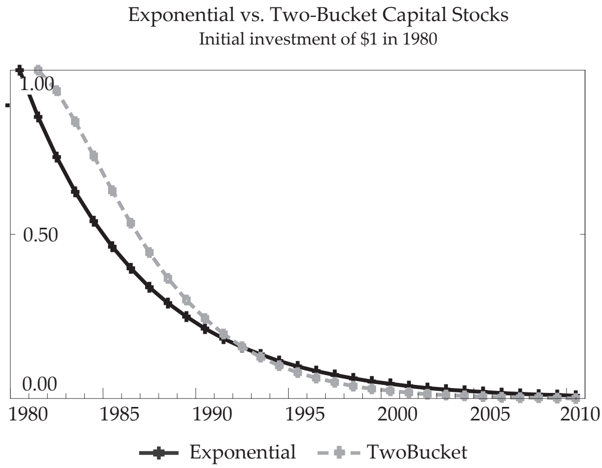
Capital input is ideally measured as a flow of capital services. One issue in the measurement of capital is to decide which types of capital to include. BLS includes equipment, structures, land and inventories. Inforum at present includes only equipment and structures. BLS assumes that real capital input is proportional to stocks, and maintains stocks at a detailed asset level for each industry. Since each type of asset has a different average service life, the service flow to stock ratio is different for each asset. The net stock and the service flow are both based on fixed “efficiency schedules”

[17] Meade (2001), pp. 165-167 presents the several of the main arguments against using the BEA/BLS computer deflators. See also Almon (2012), pp 25-26 for a discussion of the problems of using the hedonic computer deflator in economic model building.

adopted for each type of asset. Inforum calculates an average service life for each industry, based on the average composition of assets of each type, and then uses this average service flow to calculate "spill" out of the stock and to derive the net stock.

BEA's measure of net stock aims to measure the value of capital goods, as the net present discounted value of future services. They use a pattern similar to exponential depreciation where a large share of the value of each asset is lost in the first few periods. BLS aims to capture a measure of "productive capital stock" in its efficiency schedules, where a slower initial depreciation reflects the fact that new capital goods lose their efficiency slowly at first. Inforum by using a "two-bucket" system for estimating depreciation and capital stock, is closer to the BLS. Figure 3 shows the difference in constructing a "one-bucket" (exponential) vs. "two bucket" capital stock in G7, based on a one dollar initial investment in 1980.

Figure 3 – Exponential vs. Two-Bucket Capital Stocks



BLS uses the BEA investment deflators to deflate new gross investment. Inforum uses a set of Inforum-derived deflators that are based on the IO commodity prices and a capital flow or "**B**-matrix" that shows the composition of investment by asset for each industry over time.

Jorgenson and Griliches (1967) suggest adjusting the capital input measure by an estimate of capital utilization, and use electricity consumption as an indicator of utilization. They find that this adjustment reduces the residual and attributes a larger part of output growth to changes in capital input. BLS has chosen not to adjust for utilization, and Inforum is consistent with BLS in this regard.

Labor

Labor input in the BLS KLEMS-based MFP estimates consists of total hours worked, unadjusted for skill or wage levels. The BLS Current Employment Statistics and Current Population Survey are used to combine data on production and supervisory workers hours. Inforum current derives its data on employment and hours from the BEA data which are published as part of the National Income and Product Accounts (NIPA). Note that BEA includes, but BLS excludes an adjustment of misreporting for tax purposes. This can be an important factor in industries such as Retail trade or Construction. The BLS measure includes estimates by industry for self-employed and family workers, whereas the BEA does not. However, Inforum has made use of BLS data to estimate this component of total hours to add to the BEA-based data. Inforum is using BEA derived labor compensation from the NIPA to estimate the labor cost share. BLS uses an hourly wage index constructed from BLS surveys.

Energy, Materials and Services

Inforum has constructed a set of energy, materials and services aggregates from a set of detailed balanced IO tables in current and constant prices, now available from 1998 to 2010. We have compared our estimates to those constructed by BEA, and found some differences may be due to the following:

- Inforum constructs a purified "product-to-product" table at the 399 sector level in current prices. In the *LIFT* model, this has been aggregated to a 110 by 65 commodity by industry "New Use" matrix. This will differ from the BEA Use matrix used to construct the BEA KLEMS data.
- The BEA KLEMS data are based on unpublished detailed tables that underlie the published annual IO make and use tables. These of course may differ from the parallel tables estimated independently by Inforum.
- The deflation of the BEA KLEMS to constant prices is not documented by reference to a published set of constant price IO tables. The constant price estimates differ more than the current price estimates of E, M and S between Inforum and BEA.
- BEA aggregates the inputs in purchasers' prices, whereas Inforum uses producers' prices. Inforum's choice leads to a larger "service" component for each industry, as this is where wholesale and retail trade and the various transportation margins are classified.

BLS makes its own estimates of energy, materials and services, from yet another IO database. This IO framework is developed by the BLS Office of Economic Projections, and consists of a time series of current and constant price tables at about 190 sectors, based on the BEA data, but using BLS methodologies to estimate a time-series from 1993 to 2010[18]. The BLS E, M & S estimates are further adjusted to bring them into consistency with other data BLS has compiled for the MFP project. We have not yet made an exhaustive comparison of the Inforum and BLS EMS estimates.

Aggregation

Both the BLS and BEA make extensive use of chained index number techniques to aggregate the detailed inputs and outputs. BEA generally uses the Fisher chained index, whereas BLS has chosen the Tornqvist aggregation formula for almost all of its needs. The data that Inforum has used for this project is aggregated by simple adding up. While this may lead to substitution bias, we have found that it is simpler to check the aggregates using this method. A comparison of the aggregation techniques would highlight how important this issue actually is.

Projections of MFP

The new version of the *LIFT* model has an MFP function added, that forms the KLEMS components and moves forward the historical estimates of MFP, using the same data and techniques that were used to calculate MFP in the historical period. The MFP function simply reports the calculated MFP by industry, based on the forecasted *LIFT* inputs and outputs, including labor hours worked and capital stock.

The development of this modeling capability was motivated by work Inforum has been contracted to do for the Center for Medicare and Medicaid Services (CMS), and the U.S. Federal Aviation Administration (FAA). CMS is interested in historical and forecast rates of MFP growth to assist it in calculating allowable increases in the cost of services by health care providers, which is an element of the Patient Protection and Affordable Care Act passed in March 2010. The FAA is interested in studying how increases in air transportation MFP affect the costs and productivity of industries that use air transportation.

Including the module within *LIFT* is useful in the following ways:

- Forecasts of labor, capital and other factors can be examined for reasonableness by comparing projected MFP growth rates with historical growth rates. This provides an independent check on both the labor productivity and the capital investment equations.
- Alternative scenarios can be studied to analyze the effect of exogenous changes in other variables on MFP, or to examine what changes in la-

[18] These data can be accessed at http://www.bls.gov/emp/ep_data_input_output_matrix.htm.

bor, capital and other factors would be necessary to achieve a certain rate of MFP growth.

- By assuming fixed or constant pre-specified rates of future MFP growth, we could impose a direct link between capital investment and labor productivity, which is difficult to establish empirically using industry time-series data.
- The effects on MFP of alternative trends in the efficiency of energy use or the use of other intermediate inputs can be traced.
- Since *LIFT* calculates prices endogenously, from the bottom-up, the impacts of alternative growth rates of MFP on industry price growth or aggregate inflation can be determined.

The *LIFT* model with MFP was run to 2030 using the current Inforum Summer 2012 Outlook forecast. Table 6 summarizes the growth rates of MFP for 61 private industries in the forecast, comparing the 2010 to 2020 and 2020 to 2030 growth rates with the historical growth from 1998 to 2010. For some 20 industries, the projected MFP growth rates show a smooth transition from history, with either a gradual rise or decline from the historical rate.[19] Other industries show significant changes. For example, MFP in all of the mining industries had negative growth between 1998 and 2010, but has positive growth of over 1 percent in the forecast. About 20 industries display this switch from negative to positive MFP growth. For the remaining 20 industries, the results are somewhat in between, with projected growth generally increasing between 0.5 and 1.0 percent from the 1998-2010 historical period.

These differences could be due to the fact that the historical period we are using is relatively short, and includes 3 years of significant economic slowdown, whereas the forecast is generally smoother and does not include any deep recessions.

Table 6 – Historical and Forecast MFP by Industry
Average Annual Growth Rates

		1998-2010	2010-2020	2020-2030
32	Truck transportation	0,4	1,0	0,7
33	Transit and ground passenger transportation	-1,1	-0,3	-0,4
34	Pipeline transportation	1,7	-0,4	-0,5
35	Other transportation and support activities	1,1	1,2	1,2
36	Warehousing and storage	1,2	1,8	1,6
37	Publishing industries (includes software)	-0,7	2,0	1,7
38	Motion picture and sound recording industries	0,7	1,7	1,1
39	Broadcasting and telecommunications	2,7	1,8	1,7

[19] This includes industries 11-13, 16, 20, 24, 26-27, 29-30, 35, 40-42, 49, 59 and 60.

Table 6 – Historical and Forecast MFP by Industry (continued)
Average Annual Growth Rates

	1998-2010	2010-2020	2020-2030
40 Information and data processing services	4,1	3,3	2,2
41 Federal Reserve banks, credit intermediation	1,5	1,5	1,5
42 Securities, commodity contracts, and investments	2,7	2,0	1,4
43 Insurance carriers and related activities	-0,8	1,6	1,5
44 Funds, trusts, and other financial vehicles	0,4	1,9	1,4
45 Real estate	-0,7	2,3	1,7
46 Rental and leasing services and lessors of intangibles	-0,2	2,9	2,9
47 Legal services	-3,0	1,9	1,9
48 Miscellaneous professional, scientific and technical services	-0,6	1,8	1,8
49 Computer systems design and related services	2,2	3,1	2,5
50 Management of companies and enterprises	-0,3	2,3	1,9
51 Administrative and support services	-0,3	1,7	1,6
52 Waste management and remediation services	-0,8	0,9	1,0
53 Educational services	-1,4	0,7	1,2
54 Ambulatory health care services	0,2	1,7	1,8
55 Hospitals and nursing and residential care facilities	-0,2	1,3	2,0
56 Social assistance	0,3	1,6	1,3
57 Performing arts, spectator sports, museums	0,5	1,6	1,4
58 Amusements, gambling, and recreation	-0,9	1,7	1,4
59 Accommodation	1,7	1,6	1,2
60 Food services and drinking places	0,8	0,9	0,8
61 Other services, except government	-1,8	1,5	1,3

Conclusions and Extensions

The goal of this project has been to create a comprehensive and internally consistent modeling framework for multifactor productivity. This modeling framework is integrated within the database of the Inforum *LIFT* model of the U.S. which forecasts output, hours worked, investment, capital stocks and intermediate purchases in current and constant prices. In many respects, this database satisfies the underlying requirements of a set of "production accounts", as defined in Fraumeini (2006). A consistent set of such accounts allows for the analysis of the interrelationships of structural change, outsourcing, changes in import and export patterns, labor and multifactor productivity and wage and price changes. A serious difficulty with the U.S. data, which is also described in the Fraumeini paper and the comments by Corrado, is that there are two large government agencies (BEA and BLS) producing statistics and components necessary for building this framework, but that there are differences in methodology, definition, coverage and approach that create inconsistencies. For the most part, Inforum has adhered to the BEA data for IO tables, output, investment, employment, value added and prices. BEA does not publish a constant price IO framework, although they must generate one internally to derive the (KL)EMS estimates in real terms. Inforum has traditionally built its models using constant price IO tables, but only recently has BEA provided enough source data to attempt to build a balanced time series of tables in current and constant prices. Inforum is probably the only organization that compiles a time series of product-to-product tables for the U.S., and intermediate estimates derived from such a “recipe” matrix will differ from those derived by BEA or BLS.

To extend and improved what has been developed so far, we anticipate that we will:

- Derive detailed matrices of capital stock by industry by asset for equipment and structures, and experiment with Tornqvist or Fisher chain-aggregation (using asset-specific user cost weights) to obtain a better measure of capital service flows.
- Identify and try to resolve important differences in labor and intermediate inputs between the Inforum database and the BLS MFP database.
- Use scenario analysis to understand the implications of faster or slower MFP growth on labor productivity, prices and capital investment.
- Use the database developed for this project to develop improved equations for capital investment and labor demand, and prices.
- Focus more detailed attention on the health care and air transportation sector to understand the impact of differing assumptions about deflators, capital stock and output measures on MFP.

The MFP model in *LIFT*, while still in its early stages, is already a useful tool for understanding productivity growth of the U.S. economy in a consistent and comprehensive way.

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Appendix A. *LIFT* Sectoring Schemes

A-1 – Industry Sectors in ***LIFT***

Sec #	Title	NAICS
1	Farms	111, 112
2	Forestry, fishing, and related activities	113, 114, 115
3	Oil and gas extraction	211
4	Mining, except oil and gas	212
5	Support activities for mining	213
6	Utilities	22
7	Construction	23
8	Food and beverage and tobacco products	311, 312
9	Textile mills and textile product mills	313, 314
10	Apparel and leather and allied products	315, 316
11	Wood products	321
12	Paper products	322
13	Printing and related support activities	323
14	Petroleum and coal products	324
15	Chemical products	325
16	Plastics and rubber products	326
17	Nonmetallic mineral products	327
18	Primary metals	331
19	Fabricated metal products	332
20	Machinery	333
21	Computer and electronic products	334
22	Electrical equipment, appliances, and components	335
23	Motor vehicles, bodies and trailers, and parts	3361, 3362, 3363
24	Other transportation equipment	3364, 3365, 3366, 3369
25	Furniture and related products	337
26	Miscellaneous manufacturing	339
27	Wholesale trade	42
28	Retail trade	44, 45
29	Air transportation	481
30	Rail transportation	482
31	Water transportation	483
32	Truck transportation	484
33	Transit and ground passenger transportation	485
34	Pipeline transportation	486
35	Other transportation and support activities	487, 488, 492
36	Warehousing and storage	493
37	Publishing industries (includes software)	511
38	Motion picture and sound recording industries	512
39	Broadcasting and telecommunications	513
40	Information and data processing services	514

A-1 – Industry Sectors in LIFT (continued)

Sec #	Title	NAICS
41	Federal Reserve banks, credit intermediation, and related activities	521, 522
42	Securities, commodity contracts, and investments	523
43	Insurance carriers and related activities	524
44	Funds, trusts, and other financial vehicles	525
45	Real estate	531
46	Rental and leasing services and lessors of intangible assets	532, 533
47	Legal services	5411
48	Miscellaneous professional, scientific and technical services	5412-5414, 5416-5419
49	Computer systems design and related services	5415
50	Management of companies and enterprises	55
51	Administrative and support services	561
52	Waste management and remediation services	562
53	Educational services	61
54	Ambulatory health care services	621
55	Hospitals and nursing and residential care facilities	622, 623
56	Social assistance	624
57	Performing arts, spectator sports, museums, and related activities	711, 712
58	Amusements, gambling, and recreation industries	713
59	Accommodation	721
60	Food services and drinking places	722
61	Other services, except government	81
62	Federal government enterprises	n.a
63	Federal general government	n.a
64	State and local government enterprises	n.a
65	State and local general government	n.a

A-2 – Commodity Sectors in LIFT

#	Commodity Title	NAICS
1	Crop production	111
2	Animal production	112
3	Forestry, fishing and agriculture support activities	113, 114, 115
4	Crude oil extraction	211 pt.
5	Natural gas extraction	211 pt.
6	Coal mining	2121
7	Metal ore mining	2122
8	Nonmetallic mineral mining	2123
9	Support activities for mining	2131
10	Electric utilities	2211
11	Natural gas distribution	2212
12	Water, sewage and other systems	2213
13	New construction	2301, 2302
14	Maintenance and repair construction	2303

A-2 – Commodity Sectors in LIFT (continued)

#	Commodity Title	NAICS
15	Dairy products, meat and seafood	3115, 3116, 3117
16	Other foods	3111, 3112, 3113, 3114, 3118, 3119
17	Beverages	3121
18	Tobacco	3122
19	Textiles and textile products	313, 314
20	Apparel	315
21	Leather products	316
22	Wood products	321
23	Paper	322
24	Printing	323
25	Petroleum and coal products	324
26	Resin, synthetic rubber and fibers	3252
27	Pharmaceuticals	3254
28	Other chemicals	3251, 3253, 3255, 3256, 3259
29	Plastic products	3261
30	Rubber products	3262
31	Nonmetallic mineral products	327
32	Iron and steel	3311, 3312, 33151
33	Nonferrous metals	3313, 3314, 33152
34	Fabricated metal products	332
35	Agriculture, construction and mining machinery	3331
36	Industrial machinery	3332
37	Commercial and service industry machinery	3333
38	Ventilation, heating, air-conditioning and ventilation equipment	3334
39	Metalworking machinery	3335
40	Engine, turbine and power transmission equipment	3336
41	Other general purpose machinery	3339
42	Computers and peripheral equipment	3341
43	Communications and audio-video equipment	3342, 3343
44	Semiconductors and other electronic components	3344
45	Electromedical and electrotherapeutic apparatusw	334510, 334517
46	Search, detection and navigation equipment	334511
47	Measuring and control instruments	334512, -3, -4, -5, -7, -8, -9
48	Magnetic and optical media	3346
49	Household appliances	3352
50	Electrical equipment	3353
51	Other electrical equipment and components	3351, 3359
52	Motor vehicles	3361, 3362
53	Motor vehicle parts	3363
54	Aerospace products and parts	3364
55	Ship and boat building	3366
56	Other transportation equipment	3365, 3369

A-2 – Commodity Sectors in LIFT (continued)

#	Commodity Title	NAICS
57	Furniture	337
58	Medical equipment and supplies, dental labs	3391, exc. 339115
59	Ophthalmic goods	339115
60	Miscellaneous manufacturing	3399
61	Wholesale trade	42
62	Retail trade	44, 45
63	Air transportation	481
64	Rail transportation	482
65	Water transportation	483
66	Truck transportation	484
67	Transit and ground passenger transportation	484, S00201
68	Pipeline transportation	486
69	Transportation support, sightseeing, couriers	487,488,492
70	Warehousing and storage	493
71	Publishing, except software	511, exc. 5112
72	Software	5112
73	Motion picture and sound recording	512
74	Broadcasting: Cable, TV and radio	5131, 5132
75	Telecommunications	5133
76	Information and data processing	514
77	Banks, credit cards and finance	521, 522
78	Securities, investments, funds and trusts	523, 525
79	Insurance	524
80	Real estate	531
81	Owner-occupied dwellings	S00800
82	Rental and leasing of goods	532
83	Royalties	533
84	Legal services	5411
85	Professional, scientific and technical services	541, exc. 5415
86	Computer systems design and related services	5415
87	Management of companies and enterprices	55
88	Administrative and support services	561
89	Waste management and remediation	562
90	Educational services	611
91	Home health care services	6216
92	Offices of physicians, dentists, and other health practioners	6211, 6212, 6213
93	Other ambulatory health care services	6214, 6215, 6219
94	Hospitals	622
95	Nursing and residential care facilities	623
96	Child care and social assistance	624
97	Performing arts, spectator sports and museums	711, 712
98	Amusements, gambling and recreation	713

A-2 – Commodity Sectors in LIFT (continued)

#	Commodity Title	NAICS
99	Accomodation	721
100	Food services and drinking places	722
101	Automotive repair and maintenance	8111
102	Other repair and maintenance, personal services	8112, -3, -4, 812
103	Religious, grantmaking and other organizations	813
104	Private households	814
105	Postal service and federal government enterprises	491, S00102
106	State and local government enterprises	S00203
107	General government industry	S00500
108	Noncomparable imports	S00300
109	Scrap, used and secondhand	S00401, S00402
110	Rest of the world adjustment to final uses	S00600

Appendix B. Data Sources

This appendix describes the data used for this paper. Unless otherwise noted, all series used in the paper are annual and cover the period from 1998 to 2010.

A. Nominal Output by Industry

The nominal output data are derived from the 2002 benchmark input-output table, the series of annual IO tables from 1998 to 2010, and the BEA gross output series, which includes current and constant prices industry output (before redefinitions). The Inforum concept of industry output is closest to the BEA series "industry output after redefinitions" from the annual IO tables.

B. Output Price

To deflate industry output, we have compiled a series of make tables in current prices. We use commodity deflators to deflate the make tables down the column, and form the real industry output as the row sum of the deflated make table. The industry output price is formed as the ratio of nominal industry output over real industry output.

C. Labor Hours

The NIPA table 6.9 "Hours worked by full-time and part-time employees" is used as the control totals for hours worked for employees. The distribution to more detailed industries is achieved by sharing the hours worked by shares of employment in each industry. Finally, hours for self-employed and family workers are added by adjusting hours by the share of employment of self-employed and family workers to full-time and part-time employment.

D. Labor Compensation

Labor compensation includes wages and salaries plus supplements. Inforum uses the NIPA data directly. The average "wage" per hour is defined as the total labor compensation divided by total hours worked, for each industry.

E. Investment and Capital Stocks

Data on nominal investment series by owning industry is taken from the BEA *Fixed Assets* data. Fixed ratios are used to convert these series to a user basis, as defined by the 1997 Capital Flow Table published by BEA as part of the 1997 U.S. Benchmark IO table. Average service lives by industry are used to derive time series of real capital stocks. The *LIFT* model also includes its own time-series of capital flow tables, estimated and balanced by Inforum, for the period 1998 to 2010. There are in nominal and constant 2005 dollars.

F. Intermediate Purchases, Aggregated as Energy, Materials and Services

The intermediate aggregates used for the Inforum KLEMS data are drawn from the IO database used for the *LIFT* model. This database uses detail from the 2002 Benchmark U.S. IO table and the series of U.S. annual IO tables, combined with detailed data on imports, exports and industry output to create a time series of detailed make and use matrices from 1998 to 2010. These are then converted annually to a product-to-product table, based on commodity technology. The entire framework is converted to constant prices by deflating output by domestic output deflators, deflating imports by imports deflators, and deflating the rest of each row implicitly in a way that preserves the row sum in constant prices.

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PortableDyme – A simplified software package for econometric model building

Introduction

Science-based policy analysis becomes increasingly important in the globalized world. Complex economic and ecological structures need to be thoroughly analyzed, direct and indirect effects of policy measures should be identified and, if possible, quantified. Empirical research in general and macroeconomic simulation and forecasting models in particular are used to understand the possible future impacts of structural changes on economy, society and environment and to support the ex-ante evaluation of policy measures (Großmann *et al.* 2011 , Lehr *et al.* 2012, Lutz and Wiebe 2012, Lutz *et al.* 2012, Meyer 1998).

Today, a broad range of macro-econometric models exists. They differ in the underlying modeling approach, level of detail, and modeling software used. Many models are inherently complex. They contain large amounts of historical and forecasted data, hundreds to thousands of equations and require expert knowledge about the underlying set of programs and programming languages.

The modeling approach of INFORUM models is based on two characteristics: bottom-up and integrated modeling (Almon 1991). Bottom-up refers

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to the modeling of economic sectors at the industry level. The model combines econometric-statistical analysis with input-output analysis, if available, embedded in a complete macroeconomic framework. Macroeconomic variables such as GDP are calculated by explicit aggregation. Integrated modeling stands for a consistent modeling approach which reflects the interdependencies in an economy. Only a few variables such as population are given exogenously. Hence, the models represent the complete economy.

Usually, INFORUM models are based on a large dataset and the behavioral equations are empirically validated. The main assumption of the underlying economic philosophy is that agents act in imperfect markets under conditions of bounded rationality (see e.g. Rubinstein 1998). It does not assume perfect substitution of factors, and is not bound to optimization routines. Alternative hypotheses about the agents' behavior are tested by using econometric methods.

Members of the INFORUM group are entitled to use the G7/Interdyme package of software programs which forms a powerful set of tools for building sophisticated macroeconomic interindustry models. Portable is an extension of this software package which aims at beginners who are new to macroeconomic model building.

The PortableDyme Software package

For two decades, the INFORUM package of programs (i.e. Interdyme, G7) has proven to be a great resource for building sophisticated macroeconomic multisectoral models. The software offers some important advantages over its competitors.

Object-oriented approach. The design of main building blocks of a model – time series, vectors, matrices, equations, databases – follows the principles of object-oriented programming. The main advantage for model builders is that these data types are almost as easy to use as built-in data types.

Scalability. The software is able to deal with small as well as large-scale datasets made from millions of time series with a small memory footprint.

Speed. INFORUM models are made from compiled C++ code instead of interpreted code which gets evaluated at run-time. This offers outstanding performance even with large-scale models.

As with any other powerful software package, new users are facing a steep learning curve: They have to get acquainted with different computer languages/grammars, have to know how to setup a computer with the necessary software components, must be able to operate a computer with a CLI (Command Line Interface), etc.

As the name implies, PortableDyme is not a replacement for but built on top of the Interdyme/G7 software package. Thus, users are still required to learn how to operate each of these programs effectively. One of the main reasons to develop PortableDyme was to minimize the technical hurdles especially new users are facing when it comes to setting up and operating their model building environment.

Complete model building environment. PortableDyme contains almost everything that is needed to successfully build a sophisticated multisectoral model. Apart from the G7/Interdyme software, PortableDyme comes with a free C++ compiler, and advanced editor with project management features, a lightweight Microsoft Excel-based database manager and some other productivity tools.

Installation-free usage. PortableDyme is preconfigured to run out of the box without installation. Users just have to copy the PortableDyme directory to any location on the computer. Moving a model to a new computer or passing it to other model builders has never been easier.

Predefined model structure. One of the biggest challenges of model building is to organize and keep track of the vast amount of information (i.e. files). Serious problems arise rather quickly if some program is not able to find its input data or write its output data due to erroneous configuration. To minimize such problems, PortableDyme comes with a predefined directory structure which not only reflects the different steps of model building (data preparation, performing regressions, model building, reporting and evaluating) but also ensures that each of the programs is able to carry out its task flawlessly. Additionally, system files (e.g. the compiler, the model building framework) have been separated from model-specific files to further reduce complexity.

Free of charge. PortableDyme comes at no cost. It is made from carefully selected free software components. Although the creators of PortableDyme do not claim an explicit copyright, this of course does not imply that the software in general is free of copyrights: Especially the use of the embedded INFORUM software is not allowed without permission from INFORUM Maryland, USA.

Two versions of PortableDyme. It comes in two versions: The vanilla version contains everything to build a model from scratch: It contains the complete model building environment but no data, regressions, statements etc. This version is aimed at model builders who are to some degree familiar with creating INFORUM–type models. The other version contains a small but extensible macroeconomic model for Turkey built on top of the vanilla version. The dataset contains data especially from the WIOD (World Input Output Database) and from UN (United Nations) sources. The unified structure of these datasets makes it easy to adopt the Turkish model to other countries within a few hours.

The following chapter gives an overview of the basic macroeconomic model that comes with PortableDyme.

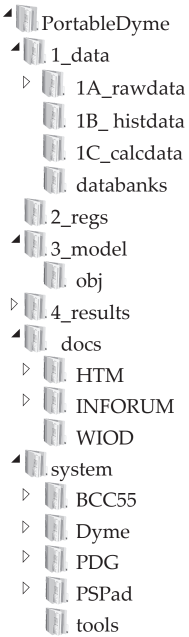
PortableDyme – a small macro-econometric IO model

PortableDyme models come with a pre-configured model and directory structure (see Figure 1 – Directory structure of PortableDyme models1). The structure reflects the necessary steps to build a macroeconomic, multi-sectoral model from scratch:

1. *Setting up and completing the historical database* (1_data, see Figure 1 – Directory structure of PortableDyme models1)

   Data preparation and data processing for the historical data (usually supplied by official statistical offices) is done here. All data are described (e.g. name, description and structure of variables). It includes the unified historical database and additionally calculated data.
2. *Doing the regressions* (2_regs)
   Includes all files necessary to do the regression analysis.
3. *Building and running the projection model* (3_model)
   Includes the actual forecasting model and combines behavioral equations and definitions.
4. *Analyzing the results* (4_results)
   Contains results from scenario analysis.

Figure 1 – Directory structure of PortableDyme models



The folder *docs* includes documentation files. It is not necessary for the model to run, it just gives explanations for the modeler about the dataset, Interdyme software and PortableDyme.

The folder *system* includes the software framework which it is necessary to build and run the model, e.g. Interdyme software package, C++ compiler etc.

The steps in the model building process are discussed in greater detail in the following sections. Note, that these steps are usually not accomplished in a strict consecutive order due to the fact that a model evolves over time and/ or errors may arise which make it necessary to return to one of the previous steps. For example, in step 2_regs "regressions" a model builder may encounter data problems which can only be solved in step 1_data.

Data collection and analysis

There are basically four steps when setting up a database for an economic model:

1. Choose data source(s),
2. Analyze data,
3. Organize data (in a databank),
4. Preparatory calculations.

The main determinant for the first step is to be clear about the aim of your modeling exercise: what exactly should be represented in the model and how. We are aiming at building a simple input-output model, which may serve as a basis for other, more comprehensive, models. Additionally, it should be easily transferable to other countries. The newly published WIOD database (Erumban et al. 2012[1]) provides readily available input-output data[2] for 27 EU countries and 13 other major countries such as Japan, Mexico and Russia, thus covering almost all INFORUM partner countries (see Table 2).

The WIOD database is complemented in our example by the UN population data (United Nations 2011, 2011a[3]). Some virtues of the WIOD database are its standardized dataset across countries and the homogenous data structure, which makes it easy to transfer the model code to other countries, i.e. all INFORUM members can simply take the data and build their own model with only few alterations to the existing PortableDyme example. PortableDyme is, however, not restricted to using the WIOD dataset as a base. It is easily possible to change the structure of the variables to include data from the national statistical offices or other international offices, such as the OECD.

[1] http://www.wiod.org/ (02/09/2012).
[2] As well as supply-and-use tables, socio-economic accounts, environmental accounts and exchange rates.
[3] http://esa.un.org/unpd/wpp/Excel-Data/population.htm (02/09/2012).

Table 2 – Countries in WIOD Database

Country	Acronym	Country	Acronym	Country	Acronym
Australia	AUS	France	FRA	Malta	MLT
Austria	AUT	United Kingdom	GBR	Netherlands	NLD
Belgium	BEL	Greece	GRC	Poland	POL
Bulgaria	BGR	Hungary	HUN	Portugal	PRT
Brazil	BRA	Indonesia	IDN	Romania	ROU
Canada	CAN	India	IND	Russia	RUS
China	CHN	Ireland	IRL	Slovak Republic	SVK
Cyprus	CYP	Italy	ITA	Slovenia	SVN
Czech Republic	CZE	Japan	JPN	Sweden	SWE
Germany	GER	Korea	KOR	Turkey	TUR
Denmark	DNK	Lithuania	LTU	Taiwan	TWN
Spain	ESP	Luxembourg	LUX	United States	USA
Estionia	EST	Latvia	LVA		
Finland	FIN	Mexico	MEX		

The next step in the model building process is a short economic and statistical analysis of the data. As this is common sense for economists, we will not go into further detail here.

A more sensible task for new model builders is the decision of how to organize your data, i.e. give variable names and store the data in appropriate data structures. There are three ways of storing data in Interdyme: as 'time series' (individual data points), as vectors or as matrices. For input-output models the choice of the data structure is straight forward as the the mathematical representation is usually given in matrix notation. The interindustry flow matrix and the corresponding intermediate input coefficient matrix can be stored as matrices, and final demand, value added and output as vectors. An easy rule is that if a variable is avaiable for different sectors, it is best to store the variables in a vector for all sectors. Vector sums, i.e. total final demand, total value added or total output are vector sums and can be stored in 'time series' or 'macro' variables as the individual data points are called in Interdyme. To easily distinguish between the data structures, it may be helpful to use a notation that immediately shows what data structure the variable is, an example is: capital letters for matrices and time series and small letters for vectors. Matrices are followed by respective number of row and column in squared brackets, vectors are followed by respective number of rows. Times series are followed by *t* in squared brackets that indicates the time (e.g. years).

In Interdyme, vector and matrix variables are stored separately from time series variables. For both types of databases, the software G7 is used to read the original data (mostly coming from Microsoft© Excel files) and to store these data in compact binary form. The user has to prepare a set of text files which contain the necessary statements for data processing (opening/ closing spreadsheet files, reading ranges of cells, assigning variable names etc.).

For most models, you need to calculate some data from the original raw data. In the case of input-output models this mostly refers to calculating the input coefficient matrix from the flow matrix and the output data given in the input-output tables. In addition, when using the WIOD data, the macro-economic values for the different final demand categories as well as total value added and total output can be calculated, before starting the actual modelling. When using PortableDyme, all of these preliminary calculations are programmed in G7, which has a large number of matrix and vector operations readily available. For the simple model, we calculated for example the following economic data (see also Table 3 and Figure 5):

- AD, AM, AT: Input coefficient matrix (domestic, imported, total),
- GDP: Gross domestic product,
- hcesq, gcesq, gfcfq, exq: Shares of final demand components,
- HCESC: Household consumption expenditures per capita,
- GCESC: Government consumption expenditures per capita.

Table 3 – Input-Output Table

Input-Output table (industry by industry)				Final consumption							
		Input	Total intermediate consumption	Finald consumption on expenditures by *households*	Final consumption expenditure by *non-profit* organisations serving households	Final consumption expenditure by *government*	*Gross fixed capital formation*	Changes in *inventories* and *valuables*	Exports	*Total final demand*	Total demand
		1 …………….. 35	Σ							Σ	Σ
Output	1 ……… 35	*Intermediate flow (domestic)* ZD_{ij}	$ticd_i$	$hcesd_i$	$cnpid_i$	$gcesd_i$	$gfcfd_i$	$cies_i$	ex_i	fd_i	td_i
Imports	1 ……… 35	*Intermediate flow (imported)* ZM_{ij}	$ticm_i$	$hcesm_i$	$cnpim_i$	$gcesm_i$	$gfcfm_i$			fdm_i	tdm_i
Primary inputs	Σ Total intermediate input	iit_j	IIT=TIC	HCES		GCES	GFCF	CIES	EX	FD	TD
	+ Taxes less subsidies on products	tls_j	TLS								
	+ Value added	$valu_j$	VALU								
	= Output	$outn_j$	OUTN								

The data collection and processing task is finished if all necessary variables for the next steps (doing regressions and building the model) have been prepared. Sometimes, at a later stage you will realize that you are missing some data. In this case, you have to go back to the data collection and processing step and include additional data. This should be considered normal since a model evolves over time.

Regressions

The Interdyme models combine (macro-) econometric modelling with input-output analysis. The model consists of basically two types of equations: definitions and behavioural equation. The parameters of the behavioural equations are econometrically estimated using the available historical data. The regression analysis is done in G7. G7 provides different estimators such as Ordinary Least Squares (OLS), Two-stage Least Squares (2SLS), Panel Data or Pooled Regressions, please see INFORUM (2011) for more details. One important feature of the Interdyme model environment is the concept of 'rho adjustment'. This includes two crucial processes: First, it corrects the estimated values for the size of the error term (rho) in the last year for which historical data is available. This is important to ensure a smooth development at the transition between the existing and the projected data. Second, it is possible to include an adjustment of this error correction term over time, so that it approaches zero as time goes to infinity, thus ensuring that over time the value allocated to the variable approaches the value given by the estimated coefficients. The rho adjustment routine is only executed if t, the current year, is larger than the last historical data. This ensures that historical data will not be overwritten.

After you have prepared all regressions, you can proceed with integrating them into the forecasting model. Including regressions within the PortableDyme environment is straight forward. The regressions and their results (coefficients) can be stored in different files depending on the context. Then all of these files are combined using a master file. The Interdyme program IdBuild translates the regression results into C++ code, which can easily be included into the code of the projection model.

Model core

The core of every economic model is the interaction between the model variables. That does not only comprise the behavioral equations. The dynamic interactions should be taken into account within the model. The model builder is responsible for finding an appropriate economic theory and for implementing it into the model.

Our example of a tiny PortableDyme model contains (at this stage) a simple IO-model and some exogenous variables such as population and exchange rates. The industry classification is based on the WIOD data, see Table 4.

Table 4 – Industry classification according to IO tables

	35 industries
AtB	Agriculture, Hunting, Forestry and Fishing
C	Mining and Quarrying
15t16	Food, Beverages and Tobacco
17t18	Textiles and Textile Products
19	Leather, Leather and Footwear
20	Wood and Products of Wood and Cork
21t22	Pulp, Paper, Paper , Printing and Publishing
23	Coke, Refined Petroleum and Nuclear Fuel
24	Chemicals and Chemical Products
25	Rubber and Plastics
26	Other Non-Metallic Mineral
27t28	Basic Metals and Fabricated Metal
29	Machinery, Nec
30t33	Electrical and Optical Equipment
34t35	Transport Equipment
36t37	Manufacturing, Nec; Recycling
E	Electricity, Gas and Water Supply
F	Construction
50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel
51	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles
52	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods
H	Hotels and Restaurants
60	Inland Transport
61	Water Transport
62	Air Transport
63	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies
64	Post and Telecommunications
J	Financial Intermediation
70	Real Estate Activities
71t74	Renting of M&Eq and Other Business Activities
L	Public Admin and Defence; Compulsory Social Security
M	Education
N	Health and Social Work
O	Other Community, Social and Personal Services
P	Private Households with Employed Persons

An overview about model structure and relations between variables shows Figure 5.

1. Total exports (EX) are determined exogenously and currently set using a 'growth fix'. Using the shares from the last year available, total exports are split across sectors.
2. You can influence variables in different ways: using a 'growth fix' means to indicate a growth rate. Other concepts such as 'multiplier fixes' and 'index fixes' are shortly described below and more extensively in INFORUM (2009).
3. Sectoral imports depend on sectoral output and the relations are estimated.

The remaining final demand components HCESC and GCESC per capita as well as GFCF are estimated at the macro level, depending on gross value added VALU (per capita) respectively output OUT. Using the UN population forecasts total HCES and GCES are calculated from the per capita values. Sectoral values for these final demand components are calculated using the shares from the last year for which data is available.

Changes in inventories are assumed to decrease by 1% annually on the sectoral level: cies[i] = CIESlag[i]*0.99.

Sectoral output is calculated using the Leontief inverse and final demand vector. Sectoral output is used in the import regression equations, thus making it necessary for the model to iterate.

Using the total coefficient matrix and sectoral output values, sectoral intermediate input and also sectoral value added can be computed, and, hence, also gross value added VALU, which is the independent variable in the HCESC and GCESC regressions, again, making model iterations necessary.

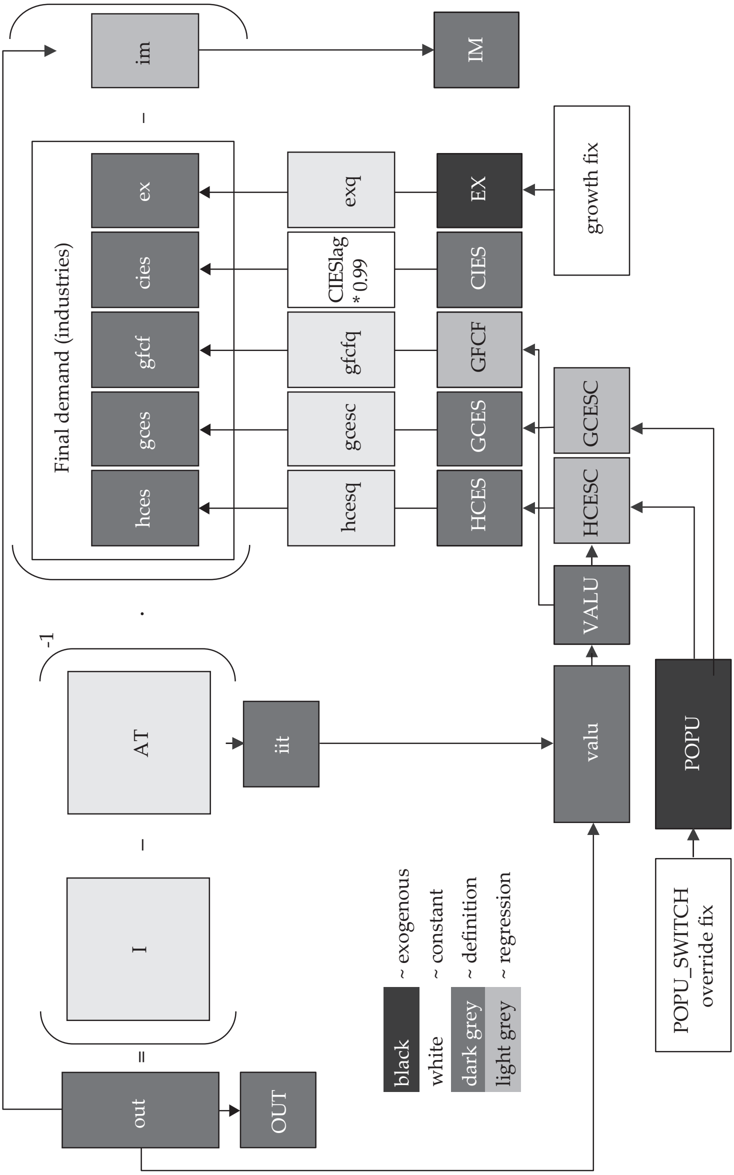
The convergence criteria are based on the changes of GDP and HCES from one iteration to the next. As soon as the change in both variables is less than 1%, the iteration stops.

The model approach is non-linear, due to the multiplicative connections of variables in identities and behavioral equations. This nonlinearity, combined with the interdependency of the system, requires an *iterative solution procedure* which is given by the Gauss–Seidel[4] algorithm.

The model iterates until the convergence criteria are fulfilled. The convergence criteria depend on the model content and should be carefully designed by the model builder. In the PortableDyme model, the iteration for one year ends as soon as the change of production OUT and household consumption expenditures HCES compared to their values in the previous

[4] This method is named after the German mathematicians Gauss and Seidel. They developed an iterative method which is used for solving non linear systems of equations. This method solves the left hand side of any equation, using previous values for the variables on the right hand side. The computation of a left hand side variable uses the elements of variables that have already been computed. In the next iteration all left hand side variables are calculated again.

Figure 5 – Model plan



iteration is smaller than 0.01%. Of course, you can alter the convergence criteria (and the maximum percentage change) and use for example the GDP a convergence criteria. This convergence procedure is executed for every year in the modeling period. The modeled time period can be altered by the modeler.

Not all variables are forecasted endogenously. For example, population is very often an exogenous variable and is available in several alternatives from e.g. United Nations. To study the effects of alternative population forecasts, you can run scenarios that are different from your baseline scenario.

The concept of 'fixes' allows the model user to specify which variant should be used. All kinds of data (vector, matrices and time series) can be influenced exogenously. Interdyme provides several ways to modify a value (More examples can be found in INFORUM 2009.):

- ovr: overrides the results
- mul: multiply the results by a factor specified
- cta: add a constant term

Also, endogenously forecasted variables can be modified by using 'fixes'. The model can run with various modifications to its equations to analyze different pathways and to test model characteristics.

These 'fixes' can easily be specified in 'fix' files. In inter-industry models, you can modify single industries or a group of industries by using a vector fix. To adjust a single industry, you select the appropriate fix (e.g. multiplier fix, growth fix), the name of the vector that should be modified and the element of the vector that corresponds to the industry. This is explained in detail in INFORUM (2000).

After finishing programming the model, you can run it. If the model runs successfully the results of the model run are stored either in the model directory or if you specify a *scenarioname* the results are copied to the directory results*scenarioname*.

Scenario analysis

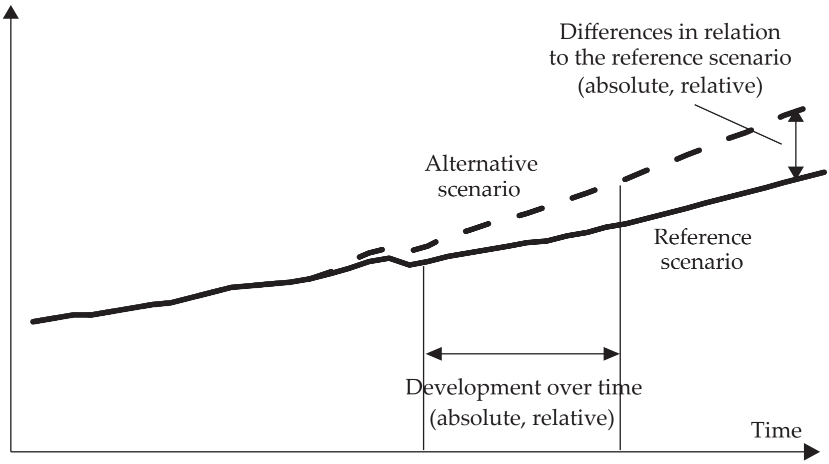
"Prediction is very difficult, especially if it's about the future." This quote is attributed to the physicist Niels Bohr, but equally or even more true in economics, because the units of observation in economics on top of everything else are having own preferences and an own will.

Economic modelers therefore have developed a methodology for dealing with the uncertainties of future development: the construction of scenarios. Scenarios are consistent sets of quantities describing the future development under given assumptions. The starting point of such analysis usually is the so-called business as usual (BAU) scenario. Here, the assumptions are: past behavior, past reactions will be exactly the same in the future. If consumers never reacted to price changes of certain goods, they will not react to it in the future. A BAU scenario is driven by population growth, international resource prices and empirically observed past responses to these quantities.

Alternative scenarios are designed addressing the research questions (e.g. policy measures) or to test the decisive relevance of certain parameters/ variables (sensitivity analysis). Changes in one of the exogenous (and also endogenous) variables will have an impact on other variables within the model. All exogenous parameters that will not be changed developed in line with the BAU scenario. Endogenous parameters vary according to modeling context.

Results of the BAU scenario and all alternative scenarios can be separately described considering the development over time for each important variable or in relation to other model variables to explain the relations. Furthermore, the modeling results can be illustrated as (absolute and/ or relative) differences to the BAU scenario (see Figure 6 – Comparing scenarios).

Figure 6 – Comparing scenarios



To see the impacts of running different forecasts modify (‘fix’) a variable, run the model and store the results in a separate folder by giving a name to your scenario.

PortableDyme have some helpful evaluation tools to analyze data for one model run or to compare results from different model runs. The three small G7-programs ‘dymelook.prg’, ‘resultlook.prg’ and ‘resultcompare.prg’ open the respective databank(s) and you can analyse your results using G7 or to write the results to an excel file for further processing.

Conclusion and outlook

The PortableDyme model building framework was presented at the 20th INFORUM conference in Florence, Italy. During a five-hour workshop, the authors instructed the participants on how to use the software and how to build the basic PortableDyme model based on country-specific data taken from the WIOD database. At the end of the workshop, more than ten country models have been built simultaneously including simple scenario analysis for population and exports.

The predefined model structure not only helps beginners and intermediate model builders to achieve results more quickly but also makes it possible to compare the results from different models due to their common dataset and variable naming convention.

There is a still a lot of room for improvement, though. From the software side, support for data and scenario analysis is very basic. At this early stage, the model itself is very simple. For example, estimations of private consumptions by households should be done at a sectoral level instead of using constant shares. Additionally, prices are missing at the moment and the labour market is not explicitly modelled. In addition, a more detailed Seidel algorithm should be used to include the import estimations directly in the IO-equation solution.

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Flow of Funds Accounts in The System of National Accounts

Introduction

Flow of funds accounts (FFA), introduced to social accounting by Keynes (1930, 1936) and later by Copeland (1947, 1949), represent financial transactions concerning acquisition and sale of financial assets as well as the incurrence and repayment of liabilities by their forms of a given institutional sector to other sectors (Pyatt 1991). Therefore, FFA are constructed as sectoral accounts with an emphasis on financial corporations because of their role in mediating almost all financial transactions.

Flow of funds accounts present differences between the values included in closing and opening balance sheets but the form of FFA being published by statistical institutions can differ since particular countries elaborated various standards in this domain. Structure and the level of disaggregation of FFA also depend on statistical data that is available in a given country.

FFA for Poland that are constructed by Central Statistical Office in Poland follow the form of European System of Accounts (ESA 95), which constitutes a coherent, consistent and integrated system of national accounts. It shows main economic processes concerning production as well as distribution and redistribution of income finally used for consumption and accumulation. In turn, accumulation account consists of four accounts: capital, financial (changes of assets and changes of liabilities), other changes in the volume of assets and the revaluation. The financial account shows how the surplus or deficit on the capital account is financed by transactions in financial assets and liabilities. Thus, the balance of the financial account

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(net acquisition of financial assets less net incurrence of liabilities) is equal in value to net lending / net borrowing, the balancing item of the capital account (*Manual on Sources and*… p. 10). In that meaning, flow of funds accounts are fully integrated with capital account by saving and nonfinancial accumulation. Hence, FFA constitute a useful statistical tool for analysis of relations among different forms of financial and nonfinancial accumulation of particular institutional sectors. In publications that are prepared systematically by Central Statistical Office in Poland values of financial transactions are aggregated to twenty one instruments of financial market (forms of financial assets) and six institutional sectors, among which there are five subsectors of financial corporations and three subsectors of general government. Two separate tables present changes of liabilities and changes of financial assets[1]. Polish statistics is also accessible in Eurostat Database but in a more aggregated form.

Applying FFA as a tool of research requires to define their form which depends on the aim of the research. Usually, FFA are used for analyses displaying the influence of financial markets' position (depending on the type of monetary policy) on subjects' individual decisions on spending incomes and other behaviors in the economy (financial and non-financial institutions). Financial forecasting, simultaneously ensuring internal consistency of financial forecasts and their consistency with forecasts made for nonfinancial economy national accounts usually requires resorting to broad FFA analysis. In the empirical research, FFA are used as statistical database in dynamic econometric models (e.g. VAR model by Bonci, Columba 2008, model QUEST by Almon 1999) or as a system of accounts treated as a deterministic macroeconomic model integrated with model of nonfinancial economy (Green, Murinde 2003, Terzi 1986). System of FFA can be presented as a deterministic model based on the input-output idea (Klein 2003, Tsujimura, Mizashita 2003) - as presented herein. In the recent years, numerous analyses based on flow of funds accounts have been conducted to explain the mechanisms of financial crisis of the first decade of the twenty first century (e.g. Dawson, 2004, Tsujimura, Tsujimura, 2011, Bonci, Columba, 2008, Roe 2003).

The main aim of this paper is to present FFA in the meaning of social accounting matrix (SAM) idea i.e. to show all transactions (also financial ones) in such way that resources on particular accounts are registered in rows and uses are registered in columns. This rule concerns also FFA's transactions which are the extension of the accumulation account's balancing item – net lending/borrowing.

[1] In comparison, USA flow of funds accounts are presented in three-dimensional matrix showing relations among sectors (debtors) that borrow from other sectors and sectors (creditors) that lend funds to other sectors taking into account also different forms of financial assets which are subjects of these transactions. FFA for USA are published in a form of compact elaboration *Flow of Funds Accounts of the United States*… from 1945 (annual) and 1952 (quarterly).

Flow of funds accounts as a part of Social Accounting Matrix

Let us remind that social accounting matrices reflect the rule of double registration of all transactions in the system of national accounts, which assures the balance of sums in rows and columns. It means that uses of every institutional sector are equal to their resources achieved in a given period of time and simultaneously expenditure made by one subject is income of another one. Similar equity takes place for objective accounts. Matrix that is constructed basing on these rules shows income circulation in the economy.

In the research department, represented by authors of the paper, different forms of SAM for Poland have been constructed. They depended on the aims of empirical analyses based on the SAM and the required level of detail of accounts. Another reason for using a given form of SAM is the accessibility of statistical data. The level of detail concerns the subjects that perform transactions and a way of grouping these subjects on particular accounts as well as the level of disaggregation of the transactions on a chosen account (Plich 2003, Tomaszewicz 2001, Tomaszewicz, Boratyński 2004, Boratyński 2005, Tomaszewicz, Trębska 2012, Trębska 2010).

Social accounting matrix that was built for the analysis, the results of which are presented in this paper consists of twelve non-zero sub-matrices (marked in grey color in Table 1.).

Usually sub-matrix 1.1 contains data on intermediate consumption, i.e. use of row materials and services during the process of production. In the version of SAM presented in the paper the intermediate consumption is aggregated to one value.

Table 1 – Applied scheme of SAM with a disaggregation of accumulation account

				USES					
				1	2	3	4	5	Total
RESOURCES	1	Production account		I		II			
	2	Means of production	Primary incomes	III					
	3	Current account	Institutional sectors						
	4	Capital account	Institutional sectors						
	5	Financial account	Financial assets						
	Total								

Parts of input-output table are marked in dark grey color.
Source: see Miller, Blair (2009), Tomaszewicz (1994, 2001), Pyatt (1991).

Sub-matrices 1.3 and 1.4 (each of them are row vectors) consist of elements of final demand by institutional sectors. In sub-matrix 1.3 data concerning the expenditures of households, non-profit institutions and general government as well as exports of goods and services is included. In turn, in sub-matrix 1.4 gross accumulation by domestic institutional sectors (gross fixed capital formation and changes in inventories) is shown.

Sub-matrix 2.1 (column vector) contains the elements of gross value added: compensation of employees and gross operating surplus, including taxes on production and imports (taxes on products and producers) less subsidies. Subsequently, all these economic categories are presented in the sub-matrix 3.2 as primary incomes of particular institutional sectors.

In sub-matrix 3.1 (column vector with one non-zero element) imports of goods and services is registered as a resource on a current account of the rest of the world sector.

Sub-matrices 3.3 and 4.4 are built basing on the data concerning secondary distribution of income. They present current and capital transfers among the institutional sectors adequately. Sub-matrix 3.3 contains also (apart from the current transfers) the uses and resources of particular sectors registered on the account of property income.

On the main diagonal of sub-matrix 4.3 gross saving by institutional sectors is registered. It is treated as a current expenditure (surplus of funds constituted as a difference between gross disposable income and final consumption) and resource on a capital account.

Transactions of the financial account are registered in sub-matrices 4.5 and 5.4. Sub-matrix 5.4 presents lending divided into eight main forms of financial assets: monetary gold and SDRs, currency, deposits, securities other than shares, loans, shares and other equity, insurance technical reserves, other accounts receivable/payable. In turn, sub-matrix 4.5 contains data on the forms of liabilities contracted by institutional sectors divided into eight groups of liabilities (mentioned above).

Sum of elements in sub-matrices 1.1, 2.1 and 3.1 present intermediate consumption and value added as well as cost of buying of imported products. Simultaneously the same value being the sum of elements in sub-matrices 1.1, 1.3 and 1.4 constitutes a total supply of products, which is the sum of intermediate demand (consumption of row materials) and final demand (final consumption, exports and accumulation). Sums in columns of sub-matrix 3.2 are primary incomes by the production factors: wages and salaries, operating surplus including taxes on products. Sums in columns of sub-matrices 1.3, and 4.3 represent disposable incomes (final consumption and saving) of particular institutional sectors. In turn, sums in columns of sub-matrix 3.3 show current transfers among sectors (as expenditures). On the contrary, sums in rows of sub-matrices 3.1, 3.2 and 3.3 constitute current resources of institutional sectors. Sub-matrices 1.4, 4.4 and 5.4 reflect distribution of capital resources of institutional sectors (accumulation, capital transfers and net lending) and their sums in columns are capital uses of particular sectors. Sums in rows of sub-matrices 4.3, 4.4 and 4.5 are capital resources of institutional sectors: saving, net borrowing and capital transfers. Sums of lending by institutional sectors reflect their financial investments. On the contrary, the sum of elements of sub-matrix 4.5 show contracted liabilities.

Sub-matrices presenting changes of financial assets (5.4) and liabilities (4.5) can be constructed in two ways. The first one consists in direct use and appropriate way of registering data from financial accounts. These sub-matrices show explicitly flows of which financial assets were positive or negative in a given period of time, which means increase or decrease in stock of a given asset. This form of sub-matrices 5.4 and 4.5 was used for calculations of coefficients measuring e.g. liabilities in relation to net worth of a given sector.

The second way of presenting data in sub-matrices connected with FFA consists in registering only positive flows as it is for all accounts in SNA (except for balancing items). If a negative flow of a given form of asset is observed, it is registered with the opposite sign on an account of liabilities and *vice versa* – decline in a stock of liabilities is registered on an account of asset of this kind with a positive sign. As a result of these recalculations sub-matrix 5.4 presents acquisition of financial assets and repayment of liabilities. In turn, sub-matrix 4.5 presents incurrence of liabilities and sale of financial assets. For instance, the sale of financial assets in a given form allows to increase capital expenditures concerning other form of assets and it should be also registered as an increase in capital resources. Balancing item of capital account – net lending/net borrowing doesn't change. This way of presenting FFA hides some part of information connected with changes of assets and liabilities of particular institutional sectors but is indispensable if SAM is used as a tool of simulation analyses, since.

Some authors suggest another way of presenting FFA in one matrix, not necessarily as a part of SAM (Pyatt 1991, Green, Murinde 2003, Tsujimura, Mizoshita 2003).

To show *flow of funds* accounts integrated with nonfinancial part of national accounts we constructed social accounting matrix for Poland for 2010. As it was mentioned above, statistical data derived from Eurostat Database was used. Some sub-matrices of SAM involved appraisal since there was no direct data for values of current (sub-matrix 3.3) and capital transfers (sub-matrix 4.4) among institutional sectors (even basing on the Polish statistics). That is why values in these sub-matrices are marked by italics. In turn, italics in sub-matrices 5.4 and 4.5 appear where original data meaning negative flows for some assets (in sub-matrix 5.4) or liabilities (in sub-matrix 4.5) were changed into positive values. For example, when a corporation buys back its own shares, the value of such purchase is registered on FFA as a decrease (negative value) in liabilities of this form. In our SAM it is registered as an increase (positive value) in this corporation's assets of the same form.

Table 2 – Social Accounting matrix for Poland, 2010 (millions of euro)

S A M 2010				USES 1	2	3	4	5	6	7	8	9	10	11
RECOURSES	production/external account of goods and services		1	402.307						217.450			66.903	149.790
	means of production	compensation of employees	2	131.797										3.009
		gross operating surplus	3	176.771										
		taxes on producers less subsidies	4	3.453										
		taxes on products less subsidies	5	42.289										
	property income		6							3.223	16.412	23.220	9.527	2.451
	current accounts	households; non-profit institutions	7		133.660	85.593	-1.219		14.584	*2.910*	*17.844*		*91.018*	*6.007*
		financial corporations	8			7.956	-29		15.911	*13.692*	*340*	*1.007*	*150*	
		non-financial corporations	9			74.251	-838		3.835		*1.532*		*364*	*1.055*
		general government	10			8.970	5.539	41.449	3.752	*93.031*	*1.194*	*6.835*	*13*	*287*
		rest of the world	11	154.070	1.146			841	16.752				2.977	
	capital accounts	households; non-profit institutions	12							20.091				
		financial corporations	13								1.705			
		non-financial corporations	14									49.136		
		general government	15										-9.882	
		rest of the world	16											13.187
	financial accounts	monetary gold and SDRs	17											
		currency	18											
		deposits	19											
		securities other than shares	20											
		loans	21											
		shares and other equity	22											
		insurance technical reserves	23											
		other accounts receivable/payable	24											
TOTAL				910.687	134.806	176.770	3.453	42.290	54.834	350.397	39.027	80.198	161.070	175.786

Table 2 – Social Accounting matrix for Poland, 2010 (millions of euro) (continued)

S A M 2010				USES 12	13	14	15	16	17	18	19	20	21	22	23	24	Total
RECOURSES	production/external account of goods and services		1	17.448	1.298	35.275	20.216										910.687
	means of production	compensation of employees	2														134.806
		gross operating surplus	3														176.771
		taxes on producers less subsidies	4														3.453
		taxes on products less subsidies	5														42.289
	property income		6														54.833
	current accounts	households; non-profit institutions	7														350.397
		financial corporations	8														39.027
		non-financial corporations	9														80.199
		general government	10														161.070
		rest of the world	11														175.786
	capital accounts	households; non-profit institutions	12				*12.177*						*10.243*			88	42.599
		financial corporations	13	*371*			*95*		*25*	678	14.375	9.702	4.381	8.692	7.165	1.181	48.370
		non-financial corporations	14				*530*	*5.146*				2.744	565	458		15.349	73.928
		general government	15	*73*				*8.981*			*1.311*	17.688	8.874	*7.293*		*1.413*	35.751
		rest of the world	16	*1.234*						79	3.469	9.741	1.619	*4.884*	215	8.141	42.569
	financial accounts	monetary gold and SDRs	17		*0*			25									25
		currency	18	604	108	26	20										758
		deposits	19	9.154	2.461	4.290	*0*	3.251									19.156
		securities other than shares	20	120	20.270	3.937	548	14.999									39.874
		loans	21	*0*	15.153	3.080	2.095	5.353									25.681
		shares and other equity	22	6.703	8.150	6.474	*0*	*0*									21.327
		insurance technical reserves	23	6.615	226	468	70										7.379
		other accounts receivable/payable	24	277	704	20.378	*0*	4.814									26.173
TOTAL				42.599	48.370	73.928	35.751	42.569	25	757	19.155	39.875	25.682	21.327	7.380	26.172	

Model FFA based on input-output techniques

Let us define matrices representing acquisition of financial assets and incurrence of liabilities as well as their relations to nonfinancial transactions (accumulation) and capital transfers. Matrix of financial assets now we mark following Klein (1983, 2003) as A and matrix of liabilities is marked by L. Thus, $m \times n$ matrix L consists of elements l_{ij} that mean liabilities of the i-th form held by the j-th sector, where $i=1, 2, ..., m$ and $j=1, 2, ..., n$). On the other side, $n \times m$ matrix A consists of elements a_{ji} that mean asset of the i-th form held by the j-th sector. In our SAM (see table 2.) sub-matrices concerning financial asset (5.4) and liabilities (4.5) are built based on A^T and L^T. In turn, changes of nonfinancial forms of property (and capital transfers) are included in $s \times n$ matrix K^T which consist of elements k_{hj}, where $h=1, 2, ..., s$ is the number of category of non-financial asset (or capital transfer) distinguished in SAM.

System of flow of funds accounts can be noticed in a form of equations corresponding to input-output model's idea (Klein 1983, 2003):

$$l=Dw, \tag{1}$$

$$w=Cl + k, \tag{2}$$

where:

l=Li - $m \times 1$ vector consisting of elements $l_i=\Sigma^{n}_{j=1} l_{ij}$ that mean issue of the i-th liabilities; is summation vector of n ones,

k=Ki - $n \times 1$ vector of elements $kj= \Sigma^{s}_{h=1} k_{hs}$ that are nonfinancial capital of the j-th sector; ; is summation vector of s ones,

a=Ai - $n \times 1$ vector of financial assets; i is summation vector of m ones,

w=a + k - $n \times 1$ vector of elements $w_j=a_j + k_j= \Sigma^{m}_{i=1} aij + \Sigma^{s}_{h=1} k_{hj}$ meaning net worth of the j-th sector (sum of financial and nonfinancial assets by institutional sectors),

D - $m \times n$ matrix of coefficients $d_{ij}=l_{ij}/w_j$ showing the i-th liability held by the j-th sector as a fraction of this sector's net worth,

C - $n \times m$ matrix of coefficients $c_{ji}=a_{ji}/l_i$ representing the j-th sector's holding of the i-th financial asset as a fraction of total issue of liabilities of the i-th form.

After simple transformation of the equations 1 and 2, it is possible to calculate vectors w, l or a as a function of k:

$$w=(I-CD)^{-1} k, \tag{3}$$

$$l=(I-DC)^{-1} Dk, \tag{4}$$

$$a=[(I-CD)^{-1} - I]k, \tag{5}$$

where I is $n \times n$ (in formulas 3 and 5) or $m \times m$ (in formula 4) identity matrix.

The elements of $n \times n$ matrix $(I\text{-}CD)^{-1}$ show increase in net worth of a given sector sector (corresponding to a number of row) as a reason of the unit increase (e.g. 1 million of euro) in nonfinancial assets of another sector (corresponding to a number of column). In turn, the elements of $m \times n$ matrix $(I\text{-}DC)^{-1}D$ show increase in the i-th category of liabilities caused by the unit increase in nonfinancial assets of the j-th sector. The elements of $n \times n$ matrix $[(I\text{-}CD)^{-1}\text{-}I]$ display increase in financial assets of a given sector as a result of the unit increase in nonfinancial assets of another sector.

If vector k and matrices D and C are known, it is possible to estimate demand for financial instruments distinguished in the system (vector l) as well as supply of these instruments (vector a) on particular financial markets.

Calculations of coefficients

This part of the paper shows the results of calculations of Klein's coefficients of D and C matrices using matrix of assets (A) and liabilities (L) based on original statistical data for Poland for 2010 (before recalculations explained above) shown in the tables 3 and 4. Some comparisons of calculations for Poland for 2008 and for 2010 with the same calculations for a few other European countries for 2010 are also made.

Basing on Klein's formulas and Eurostat Database, matrices and for 2010 are shown in tables 5 and 7[2].

Table 3 – Elements of matrix A for Poland for 2010 (millions of euro)

Assets / Sector	Monetary gold and sdrs; currency	Deposits	Securities other than shares	Loans	Shares and other equity	Insurance technical reserves	Other accounts receivable / payable
Households; non-profit institutions	604	9.154	120	-249	6.703	6.615	277
Financial corporations	83	2.461	20.270	15.153	8.150	226	704
Non-financial corporations	26	4.290	3.937	3.080	6.474	468	20.378
General government	20	-1.311	548	2.095	-7.293	70	-629
Rest of the world	25	3.251	14.999	5.353	-1.801	0	4.814

Source: Eurostat Database.

[2] Since in FFA don't exist flows connected with monetary gold and SDRs as a form of liabilities, it was impossible to calculate elements of the first row of matrix , so we had to put together monetary gold and SRDs with currency, thus the number of financial assets distinguished in the system was decreased to seven.

Table 4 – Elements of matrix L for Poland for 2010 (millions of euro)

Liabilities \ Sector	Households; non-profit institutions	Financial corporations	Non-financial corporations	General government	Rest of the world
Monetary gold and SDRs; currency	0	678	0	0	79
Deposits	0	14.375	0	0	3.469
Securities other than shares	0	9.702	2.744	17.688	9.741
Loans	9.994	4.381	565	8.874	1.619
Shares and other equity	0	8.692	458	0	3.083
Insurance technical reserves	0	7.165	0	0	215
Other accounts receivable/payable	88	1.181	15.349	784	8.141

Source: Eurostat Database.

Table 5 – Elements of matrix for Poland for 2010

Liabilities \ Sector	Households; non-profit institutions	Financial corporations	Non-financial corporations	General government	Rest of the world
Monetary gold and SDRs; currency	0,000	0,014	0,000	0,000	0,002
Deposits	0,000	0,297	0,000	0,000	0,085
Securities other than shares	0,000	0,201	0,037	0,667	0,239
Loans	0,236	0,091	0,008	0,335	0,040
Shares and other equity	0,000	0,180	0,006	0,000	0,076
Insurance technical reserves	0,000	0,148	0,000	0,000	0,005
Other accounts receivable/payable	0,002	0,024	0,208	0,030	0,200
Sum	0,238	0,024	0,259	1,032	0,647

Source: authors' calculations based on Eurostat Database.

As written above, elements of matrix show changes of liabilities in relation to net worth of a given sector. Comparing elements in particular columns it can be seen which form of liabilities constitutes prevalent part of total borrowing changes of a given sector. Moreover, sums in columns can be interpreted as a coefficient of the unit value of accumulation (financial and nonfinancial) financing by external sources.

In 2010 net incurrence of liabilities of general government even surpassed net worth of this sector, it was connected especially with borrowing in a form of securities other than shares and loans (see the fourth column of matrix). Calculations which was made also for 2008 show that both securities other than shares and loans contracted by the general government in relation to its net worth increased significantly in 2010. It reflects also in negative gross saving of this sector as an effect of worsening the position of public finances in general. On the contrary, we can see a significant decrease in total borrowing of households (put together with non-profit institutions), mainly loans in relation to their net worth. To a great extent, it was a consequence of restricted policy of commercial banks in the case of granting loans, especially for private units. Non-financial corporations financed their net worth using their own saving and external sources such as trade credits and advances or securities other than shares. Financial corporations used each form of financial liabilities for financing their net worth, mostly deposits (lodged by other sectors) and securities other than shares.

Comparing coefficients of matrix for Poland for 2010 with those calculated for other European countries relatively low coefficients of financing accumulation by external sources for non-financial corporations (except for United Kingdom and Sweden) and general government (except for Hungary and Sweden) can be noticed. In almost every country the highest coefficients for general government and relatively high coefficients for financial corporations are observed. This is one of the consequences of the worldwide financial crisis and restricted policy of monetary institutions.

Table 6 – Coefficients of financing accumulation by external sources (sums of matrix columns)

Country \ Sector		Households; non-profit institutions	Financial corporations	Non-financial corporations	General government
Poland	2008	1,204	0,950	0,480	0,635
	2010	0,238	0,955	0,259	1,032
Germany	2010	0,014	0,610	0,319	1,014
Italy	2010	0,506	0,445	0,328	1,769
France	2010	0,282	0,961	0,426	1,673
United Kingdom	2010	0,305	0,785	0,105	2,315
Spain	2010	0,044	0,121	0,286	1,815
Hungary	2010	-0,210[a]	-1,099[b]	-3,330[b]	0,679
Sweden	2010	0,650	-0,389[a]	0,046	0,115
Latvia	2010	-0,653[a]	-1,561[a]	0,013	1,086

[a] Negative sign of the coefficient as a consequence of negative net acquisition of liabilities.
[b] Negative sign of the coefficient as a consequence of negative net worth (negative net incurrence of financial assets).
Source: authors' calculations based on Eurostat Database.

Table 7 – Elements of matrix for Poland for 2010

Assets / Sector	Monetary gold and SDRs; Currency	Deposits	Securities other than shares	Loans	Shares and other equity	Insurance technical reserves	Other accounts receivable / payable
Households; non-profit institutions	0,798	0,513	0,003	-0,010	0,548	0,896	0,011
Financial corporations	0,110	0,138	0,508	0,596	0,666	0,031	0,028
Non-financial corporations	0,034	0,240	0,099	0,121	0,529	0,063	0,798
General government	0,026	-0,073	0,014	0,082	-0,596	0,009	-0,025
Rest of the world	0,033	0,182	0,376	0,210	-0,147	0,000	0,188

Source: authors' calculations based on Eurostat Database.

Sums in each columns of matrix **C** always equal to 1. Therefore, it can be seen which sectors are the main suppliers of a given form of assets as a source of financing liabilities of this form. For example, deposits (as liabilities of financial corporations and the rest of the world sector) were covered especially by households (put together with non-profit institutions) and non-financial corporations. It is observed that the coefficient showing the role of household in financing deposits decreased (from 0,912 in 2008 to 0,513 in 2010) and simultaneously this coefficient for non-financial corporations increased (from 0,158 in 2008 to 0,24 in 2010). It means that sector of non-financial corporations decreased its capital fixed formation under uncertain crisis situation to the advantage of an increase in financial saving especially in a form of deposits and shares and other equity. As a consequence of this, the role of non-financial corporations in financing total borrowing in the economy grew up (saving rate of this sector increased from 25,5% GDP in 2008 to 32% in 2010).

Comparing coefficients calculated for Poland with those for Germany and United Kingdom (as examples) it is clearly seen that the role of the rest of the world in financing total borrowing is significantly greater in Germany and United Kingdom than in Poland. It proves relatively high level of international integration of financial markets in those countries. Significance of foreign investors in Poland and other countries of Central-Eastern Europe is still considerably lower than in early EU member states but is growing up[3]. It seems that the relatively weak relations among polish economy and foreign financial institutions might be one of the reasons

[3] basing on analyses of the changes of investors' structure on particular financial markets (see *Financial System Development in Poland in 2002-2003, 2004, …, 2011*)

that the economic effects of financial crisis were less perceptible in Poland than in other EU member states.

Table 8 – Elements of matrix for Germany for 2010

Sector \ Assets	Monetary gold and SDRs; currency	Deposits	Securities other than shares	Loans	Shares and other equity	Insurance technical reserves	Other accounts receivable /payable
Households; non-profit institutions	1,430	2,152	-0,051	0,000	0,130	0,909	0,026
Financial corporations	-0,299	-5,664	0,020	0,431	0,533	0,019	0,057
Non-financial corporations	-0,346	0,288	0,118	0,183	0,391	-0,009	0,844
General government	0,035	1,244	0,377	0,107	0,046	0,000	0,072
Rest of the world	0,180	2,981	0,536	0,279	-0,100	0,081	0,002

Source: authors' calculations based on Eurostat Database.

Table 9 – Elements of matrix for United Kingdom for 2010

Sector \ Assets	Monetary gold and SDRs; currency	Deposits	Securities other than shares	Loans	Shares and other equity	Insurance technical reserves	Other accounts receivable /payable
Households; non-profit institutions	0,953	0,124	-0,017	0,046	0,057	1,227	0,253
Financial corporations	-0,090	0,462	0,396	-0,196	0,301	-0,012	0,319
Non-financial corporations	0,112	0,184	0,044	-0,001	0,338	-0,114	-0,014
General government	0,009	-0,033	0,051	0,068	0,008	-0,007	0,341
Rest of the world	0,017	0,263	0,526	1,083	0,296	-0,093	0,101

Source: authors' calculations based on Eurostat Database.

Some extensions

Although the Polish FFA began to be constructed in 1995, only full integration with national accounts after a few years of works to adapt existing sources of reporting to requirements of ESA'95 methodology makes it possible to start empirical research based on FFA. To our knowledge, this is the first trial of empirical analysis based on flow of funds accounts integrated with social accounting matrices for Poland. We hope that our investigation will be extended in the future for the purpose of conducting deeper analyses.

Extension can concern the following aspects.

1. Simulation analyses showing macroeconomic effects of increase in chosen expenditures (e.g. capital uses of a given sector) on resources on all accounts distinguished in SAM, not only financial accounts. Also, feedbacks effects among production accounts and income redistribution registered on current and capital accounts of all institutional sectors should be taken into consideration.
2. Enclosing the deterministic model based on SAM (with flow of funds accounts) to econometric multisectoral macromodel (INFORUM) taking into account the effects of changes of interest rates, prices and wages related to the rate of investment and saving, which influence demand and supply on financial markets by making coefficients of matrices C and D variables.

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L. Ghezzi

Households Consumption in Italy. The INFORUM approach for a new multisectoral-multiregional model

"All production is for the purpose
of ultimately satisfying a consumer."

J. M. Keynes
The General Theory of employment, interest and money,
Book 2, Chapter 5, Section 1, p. 46, 1935

Introduction

This paper will show some progress in the building process of a new Italian multi-sectoral multi-regional model called DANTE[1]. This model is based on the typical approach shared in the INFORUM research group[2] and so it is essentially a macro-econometric tool, as the focus is the general economic system represented through the National Accounts, with an inter-industry detail of the production process, thanks to the Input – Output Tables for the economy of italian regions, and a dynamic spirit, as the final goal is to explain the long term development of Italy.

A specific feature of DANTE is that it goes further a national model in order to a better analysis of structural changes and to a better responses in terms of policy analysis. Italy is characterized by an high degree of inequality in terms of economic conditions, particularly evident at regional level[3]. For this reason DANTE is developed using a disaggregated perspective[4] and its dataset is broken up into three macro-areas: Center-North, South,

Leonardo Ghezzi: IRPET (Regional Institute for Economic Planning of Tuscany).

[1] The acronym stands for Dynamic Analysis of the National and Tuscan Economy. This project was started at the beginning of 2011 in IRPET in order to provide a model able to simulate different policy options in the long term.

[2] INFORUM is the Interindustry Forecasting Project at the University of Maryland. It was founded at the end of 60's by Prof. Clopper Almon and it is dedicated to improving business planning, government policy analysis, and the general understanding of the economic environment. This project is made up of many different international research group. http://www.inforum.umd.edu/

[3] See Cherubini-Paniccià contibution in this volume.

[4] The idea of this model is to use all the experience reached in the last 30 years with INTIMO (Grassini, 2001) model, the italian model linked to the INFORUM project, and to implement it using regional data.

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and Tuscany. Thanks to data produced in IRPET, DANTE is composed by three different model, one for each region, linked together using interregional trade matrix estimated outside the model through a modified-gravity approach[5].

It is not the main task of this contribution to describe in detail the structure of the whole model but the paper will focalize attention on the demand system. In particular, the matter under discussion is the resident consumption behavior introduced in DANTE, and so which kind of data we use, which kind of theory we rely upon, which kind of specification we employ and the estimation results.

This paper does not provide a review of the literature on consumption equations and demand systems. This study has a more pragmatic orientation and so the following pages will be concentrated on the estimation of Consumption Behavior. The strategy settled to deal with this problem is to introduce two blocks in DANTE: the first one, at an aggregate level, is based on the Life Cycle Hypothesis and it is used to obtain the total of resident consumption detailed at regional level; the second one is a system of equations oriented to produce an estimation of price and income elasticities for many different items at national level.

These two blocks lie at the heart of DANTE. Using Regional data published by the Italian National Institute of Statistics (ISTAT) it is evident the role of personal consumption in the economy. Households expenditures make up approximately two-thirds of the GDP both in North and South of Italy. For Tuscany the weight of domestic personal consumption is approximately 64%. Since the dynamic of this demand's component affects production and employment in a so strong way it is really important to have a good forecast of consumption in any long term economic model. As Almon *et al* (1973) wrote almost 40 years ago describing a structural model built to produce long term forecasts of the American economy "no part of the model is more crucial than its consumption equations". The same is true also for the multiregional Italian model.

The matter about the role of consumption in the long term forecast of the economy could not be answered just introducing the first block (macro – level) in DANTE. The aggregate equation alone is not enough. Personal Consumption absorbed the same share of GDP observed in 2011 also ten years before, and twenty years ago was the same. Yet within this apparent stability, households have changed a lot their pattern of expenditures. This evolution has changed the impact of personal consumption on imports and on production and so it is crucial for a long term forecasting model to consider also the composition of the total consumption and the role of the main explanatory variables, i.e. prices and income, determining this alteration.

[5] Cherubini, Paniccià (2013).

The first part of the paper will describe briefly the theoretical background of Aggregate Consumption Equation estimated at regional level using Regional Accounts data (second paragraph), the dataset used to implement the estimation procedure (third paragraph), and the results obtained (fourth paragraph). The second part will describe briefly the Perhaps Adequate Demand System, to remind the heterodox approach suggested by Almon (1979), estimated for Italy in order to fully introduce the role of prices in the decision of consumption of different goods and services.

Aggregate Consumption Equation: a regional estimation for Italy

Estimation of the effects on the production system due to households consumption imposes to link the expenditures of all the people with the relative prices variations, and also with the level of disposable income, and finally with the demographic changes.

In order to introduce such features in DANTE we decided to use a double-step procedure: i) to determine the total amount of resident consumption; ii) to detail this information describing different path for different items in response to different prices behavior. The second step will be described in the third paragraph where it will be shown the results of PADS estimation. This system of equations for different goods and service works considering total amount of consumption (a proxy of income) as an exogenous determinant. And so, before to use PADS we need to establish the total amount of resident consumption.

This paragraph will describe the estimation at regional level of the aggregate equation for household consumption behavior[6].

The Background

As many other aspects of the model building, also the theory upon which is depicted the relationship among consumption, income and price has changed a lot during the last fifty years. Obviously, this evolution has been translated into the specification of the aggregate equations to be estimated. The main aspect we derive, starting from the empirical literature of the seventies, is the conviction that an equation inspired to the Life-cycle Hypothesis (LCH), as economic paradigm to explain the aggregate behavior of consumption, con be very useful to produce forecasts of the total amount of households expenditures. This belief is based on empirical

[6] The decision to model consumption is not the only one; for example, the US model *LIFT* (Meade, 2001), focalize attention on saving rate obtaining indirectly the total amount of consumption.

results obtained using aggregate data more than on theoretical basis, but as preliminary stage in the development of DANTE it could be considered adequate and so we decided to introduce the LCH in DANTE. Taking this decision we exploited also the experience built up during a fourty-year discussion about this subject inside the Bank of Italy[7] (BdI) presented by Guiso (1993) and so for this block we derived our inspiration also by the macroeconomic model of the BdI.

Using this approach we tried to explain the per capita consumption using income, real interest rate, and net financial wealth as explanatory variables. The relationship among aggregate households consumption and its determinants could be described starting with

$$c = \alpha_1 \cdot YD^e + \alpha_2 \cdot W_{-1} \qquad [1]$$

with $\alpha_2 = f(\mathrm{r})$ where YD^e is the expected per capita disposable income, W is the average wealth for resident, c is resident consumption, and r is the real interest rate. To estimate these equations we made use of the specification typical of an Error-Correction-Model and so we distinguish the short run equation and the long run path of consumption.

Let's start considering the long run path. The equation for private consumption features a long-run relationship between household expenditures at constant prices, real disposable income, real household net financial assets, and population and it is specified as follow

$$\log\left(\frac{c}{p}\right) = \beta_0 + \beta_1 \cdot \log\left(\frac{YD}{p}\right) + \beta_2 \cdot \log\left(\frac{W}{p}\right) \qquad [2]$$

According to the theory an hypothesis useful for the model is the homogeneity of degree one with respect to income and wealth and to respect it the sum of the parameters β_1 and β_2 should be equal to one.

Following the 'error correction model', the specification of the short run equation should be something like this:

$$\dot{\Delta}\left(\frac{c}{p}\right) = \gamma_0 + \gamma_1 \cdot \dot{\Delta}\left(\frac{YD}{p}\right) + \gamma_2 \cdot \Delta(r_{-1}) + \gamma_3 \cdot ecm_{-1} \qquad [3]$$

where the rate of growth of real resident consumption is explained using a constant term y_0; $\dot{\Delta}\left(\frac{YD}{p}\right)$ is the rate of growth of disposable income (deflated by the general index of prices); $\Delta(r_{-1})$ is the real interest rate in the short term lagged one year; ecm_{-1} is the lagged residual of the long run regression.

[7] Modigliani, Tarantelli (1974); Guiso, Jappelli, Terlizzese (1994); Ando, Terlizzese (1994); Frasca, Tarantelli, Tresoldi, Visco (1975); Rossi, Tarantelli, Tresoldi (1980), just to mention some works.

Aggregate Data at Regional Level

The dataset for regional estimation of the aggregate equation is a mix of sources. In particular, we use the Regional Accounts published by ISTAT about domestic consumption and population, IRPET data for tourism in order to transform the domestic consumption in resident expenditures, and the data of BdI for households wealth. The final result is an annual dataset starting in 1980 and ending in 2010.

The Household consumption used in the equations is the resident household consumption in nominal term divided by the general index of prices[8]. Inside the resident consumption there are different kind of expenditures: for non-durables, for durables, and for services. The aggregate equation was estimated at the regional level and so resident consumption consider the cost for tourism abroad (outside the regional border).

In the original version of LCH the variable used to explain consumption is the labor income but it's possible to demonstrate[9] that we can use also the total disposable income. This variable is in nominal term and should be deflated using the general index of prices.

About wealth the equation was estimated using the net financial wealth, and so it does not consider the investment in real assets like i.e. the investment in houses. The problem here, not just a practical problem but also a theoretical one, is what is the right deflator for financial wealth. For simplicity it is used the same as before: the general index of prices. The last variable, the real interest rate in the short term, is the rate of interest of Italian treasury bond with maturity less than one year.

Estimation of the Aggregate Consumption: Problems and main results

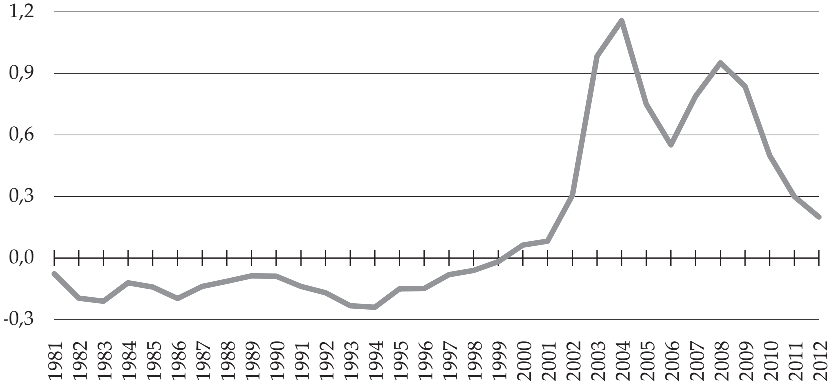
The estimation gives us some good results but we needed to solve some problems. The first one we encountered is in the estimation of long run path of consumption for Tuscany. It is necessary to force the equation introducing hard constraints in order to respect the property of homogeneity of degree one[10] with respect to income and wealth.

A second problem with the estimation of long term equation is related to population. In the graph 1 the population in Tuscany is observed for all the period covered by the dataset. Looking at the yearly percentage change in population for Tuscany it's easy to observe a sort of structural break starting in the 2002 - 2003; the increase in the rate of growth is due to an

[8] The same index will be used also in the second block when the system of equation for different goods and services is estimated.
[9] Modigliani (1975).
[10] Without this restriction the results are a lit bit more than unity (roughly 1.4).

administrative problem[11] and the magnitude is so evident that is a problem to use it in the estimation.

Graph 1 – Rate of growth of population. Tuscany



Source: ISTAT.

This event produces some problem with the long run estimation and so we decide to produce a different specification, without variables divided by population, to get over this problem. Obviously, this decision eliminated completely demographic factor in the aggregate analysis but the possibility to use the survey on households to estimate PADS in the following block give us the possibility to re-introduce a 'corrected population'. The following table contains results of the estimation obtained using aggregate data:

Table 1 – Long run regression

	North	Tuscany	South
Constant term	-0.60541	-0.65161	-0.22768
Disposable income	0.691024	0.624913	0.818908
Net financial Wealth	0.308976	0.375087	0.181092
R-squared	0.948463	0.917344	0.975734
Adjusted R-squared	0.946481	0.914283	0.974836
S.E. of regression	0.043967	0.055301	0.027184

[11] In the last ten years Tuscany and, in general, Italy has had a process of regularization of illegal immigrants. Many immigrants were in Italy but they weren't registered and so, for this reason, especially in the Center and in the North of Italy, we have observed a rise in the rate of growth. This people were in Italy also many year before the regularization and so we cannot observe the same rise in the rate of growth of consumption.

Results obtained in this way give us the possibility to compute the residual of the regression and to put them into the short run equation.

Using the results obtained for the long run path of consumption we can implement the short run estimation (using the [3]). According to this specification we should obtain the fifth parameter with a negative sign. As indicated in the table 2 the results obtained are different for different regions but every time the sign is right. Also the other parameters have the right sign: the rate of growth of households disposable income is positively related to the rate of growth of households consumption; the opposite is true for the absolute variation of real interest rate. The short run multiplier is between 0.61 (north) and 0.35 (Tuscany).

*Table 2 – Short run regression**

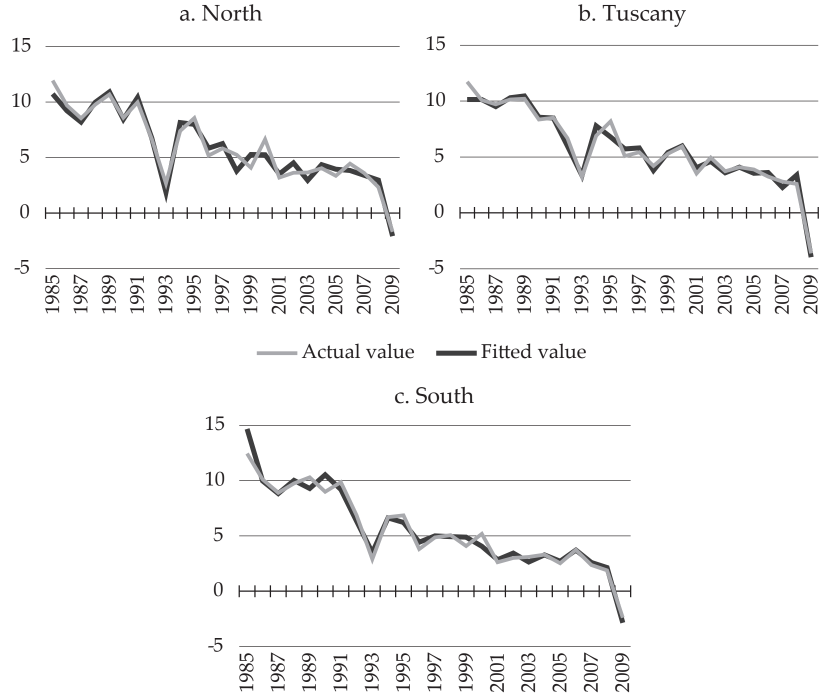
	North	Tuscany	South
Constant term	0.012708	0.013395	0.009581
DLOG(Disposable income)	0.610902	0.349524	0.455558
D(real interest rate (-1))	-0.004037	-0.00516	-0.00578
ECM (-1)	-0.108931	-0.13497	-0.36728
R-squared	0.936836	0.899699	0.948256
Adjusted R-squared	0.909202	0.864299	0.925618
S.E. of regression	0.004734	0.005576	0.004578

* The estimation was made using dummy variables: in general we use dummies for 1998 (incentives for new automobiles); 2001-2004 (introduction of Euro). In the estimation for North we introduce a dummy also for 2000; in the regression for Tuscany we use a dummy for 1988-1989; the same for South.

It is not so easy to justify this differences, probably something related to the economic structure. For example the low level of the parameter 2 for Tuscany with respect to other region is probably linked with the very high level of small firms that you can find in Tuscany respect to other region. To understand what is the influence of the structure and the size of firms in the short run equation it is useful to consider that disposable income of households is made up of different components: labour incomes of employees, capital incomes, pensions, and the labour incomes of self-employed. Each component is characterized by a different level of stability and has different level of guarantees and so the people reacts in a different way to movement of different components. The self-employed income is less stable with respect to other income sources. The role of self-employment is bigger in Tuscany than in other regions and it could be the reason of a small parameter fo income in this region respect to North and South.

Graph 2 illustrates the rate of growth of consumption and it is a good way to affirm that the aggregate equation behavior is pretty good.

Graph 2 – Rate of growth of resident households consumption. Nominal term



A Demand System: The INFORUM approach

This paragraph will describe the implementation of annual time series equations which are estimated using the PADS approach suggested by Almon (1979) and developed by other works[12]. The number of equations were estimated for Italy is 41; it includes different items of personal consumption expenditures, starting from food and considering personal care services[13]. Data we need to implement this step are not included in the Regional Accounts published by the national statistical office; resident consumptions for 41 commodities used are the final result of a different mix of sources.

The main problem is that in Italy we have information at regional, and also at national, level just for domestic consumption divided in 12 catego-

[12] Devine (1983), Chao (1991) Bardazzi, Barnabani (2001)
[13] See Appendix.

ries of expenditures[14] but not for resident consumption. The procedure introduced to solve this data-problem takes into account the role of tourists consumption expenditures, for different kind of goods and services, outside the regional border by resident and tourists consumption expenditures for different categories inside the regional border by foreigners[15]. In this way we translate domestic informations in resident informations. After this preliminary step, the problem was to expand the number of categories we had (just 12 categories). In order to figure out this problem it was used the micro-data contained in a survey on households consumption habit[16] by ISTAT. This data gives us the possibility to obtain a more disaggregated level of information, 41 categories at regional level, coherent with the data for resident consumption created in the first step starting from the Regional Accounts.

Dataset problems include also the informations about prices, for every region and every commodity. At this preliminary stage we have some difficulties to knows the prices dynamics at regional level and so we decide to aggregate regional information to obtain the national level in order to perform PADS estimation for Italy using the same raw data.

The solution of 'dataset-problem' was followed by the estimation of PADS. The main reason to choose this approach is that this system allow a great deal of flexibility with respect to products complementarity and substitutability since the demand for each commodity is allow to depend upon prices of all goods. Besides, the pragmatic orientation of PADS is coherent with our 'simplistic' necessity to develop a good macro-economic model, i.e. able to replicate the movement of the economy in the past and give credible long term forecast useful to simulate alternative policy options, without the 'ambition' to test any micro-founded theory.

PADS: few pictures to describe a beautiful paint

The INFORUM approach to personal consumption expenditure modeling has been described in a number of papers and so this part of the work does not describe in detail all the characteristics of this system[17]. PADS, in its complete version, should be summarized as a two-stage approach used to link a cross-section and a time-series analysis. In this paper it is implemented using just the times-series module. Specifically, the times-se-

[14] Food, Non Alcoholic Beverages; Alcoholic Beverages, Tobacco; Clothing and Footwear; House; Furniture, House Maintenance; Health Care; Transportation; Communication; Recreational Services; Education; Education; Services and Good n.e.c.. For the national level the number of commodities is 41.

[15] Obviously the concept of 'foreigner' is not linked to the nationality because also Italian people are considered foreigners when they decide to consume in a an italian region different form their own residence region.

[16] Indagine sui Consumi delle Famiglie Residenti, ISTAT.

[17] It is possible to find a complete description of PADS in Almon (2011).

ries equations system in PADS was developed to obtain a functional form with a lot of features but, essentially, the main aspect could be that: i) it is designed to deal with a significant growth in real income as could be the case in a long term simulation. In particular, the demand system is able to avoid negative numbers on the consumption of some items; ii) it is designed to deal with a change in relative prices. In particular, a demand system should be able to consider both complementarity and substitutability effects on the consumption of goods and services; iii) other than these two aspects, it should be able to deal with the effect of relative price changes on the marginal propensity to consume (with respect to income).

These basic requirements for a useful demand system are very clear and simply to understand. No one of these is satisfied by the wide used AIDS proposed by Deaton and Muellbauer (1980). This is sufficient to justify because DANTE will have at the heart of his engine PADS and not the very famous system proposed by Deaton and Muellbauer.

The starting point to briefly describe PADS is the general form introduced by Almon (1979)

$$x_i = (a_i + b_i \cdot \frac{y}{P})\prod_{k=1}^{n} p_k^{c_{i,k}} \qquad [4]$$

with x_i the real per capita resident consumption of i; a_i is a term with a constant and, eventually, a time trend; y is the total amount of consumption defined with the aggregate equation estimated in the previous paragraph; p_k is the price of k; P is the general index of prices[18]; $c_{i,k}$ are constants satisfying the condition $0 = \sum_{i=1}^{n} c_{i,k}$.

The functional form [4] presents some attributes as for example the homogeneity of degree zero in prices and income, constant price adding up, Slutsky symmetry in the base year. Notwithstanding, there are also some problems.

The first problem is that it does not guarantee the adding up property at every price. To be sure that consumption exhausts income also in a year other than the base year the formula [4] should be improved adding a “spreader” that: i) take the difference between the total sum of consumption simulated with [4] and the total amount defined by y; ii) spread this difference among all the items giving more to that goods with a relative high income elasticity.

Another problem that [4] poses is the large number of parameters to be estimated. In order to solve this problem Almon suggested first of all to use the Slutsky symmetry and after that he introduced the idea of groups (and sub-groups). The idea is to assume

[18] $P = \prod_{k=1}^{n} p_k^{s_k}$ where s is the budget share of k in the base year (all price are equal to 1).

$$\lambda_{i,j} = \frac{c_{i,j}}{s_j} \qquad [5]$$

where s_j is the share of consumption in j respect to total amount of consumption, and then using Slutsky symmetry imposing

$$\lambda_{i,j} = \lambda_{j,i} \qquad [6]$$

it cuts the number of parameters by a half. Now if we use the idea of groups (and sub-groups) as follow

$$\lambda_{i,j} = \lambda_i + \lambda_j + \mu'_G + \nu'_g \qquad [7]$$

where μ_G' and υ_g' are constant equal for each item included in the same group G (in the same sub-group g) otherwise are zero, we obtain a reduced number of parameters to be estimated. Specifically, this hypothesis gives a number of parameters that is n (number of items) + N_G (number of groups) + N_g (number of sub-groups) and the final form of the system is

$$x_i = \left(a_i + b_i \cdot \frac{y}{P}\right)\left(\frac{p_i}{P}\right)^{-\lambda_i} \cdot \prod_{k=1}^{n}\left(\frac{p_i}{p_k}\right)^{-\lambda_k \cdot s_k} \cdot \left(\frac{p_i}{P_G}\right)^{-\mu_G} \cdot \left(\frac{p_i}{P_g}\right)^{-\nu_g} \qquad [8]$$

where $P_G = \left(\prod_{k\in G} p_k^{s_k}\right)^{1/\sum_{k\in G} s_k}$ and $P_g = \left(\prod_{k\in g} p_k^{s_k}\right)^{1/\sum_{k\in g} s_k}$; $\mu = \mu' \cdot \sum_{k\in G} s_k$ and $\nu = \nu' \cdot \sum_{k\in g} s_k$.

Estimation results

PADS as expressed in the [8] is estimated for the period1980 - 2007 using annual data for resident consumption elaborated as described at the beginning of this paragraph. In order to adopt a reasonable number of parameters the number of group is 10 and the number of sub-groups is 3. The estimation is performed using 41 items and the results obtained are shown in the following table 3. As we said before, PADS was estimated at national level because to perform it at the regional one we need to know the price of each item in every region. At the present we don't know this information and so, in order to introduce the results in DANTE, we consider this national level estimation as a first guess, as good as possible, for each region.

The estimation of the own price elasticity and the income elasticity is included in the table; there is also the time trend component and the average error committed using this system in percentage to consumption observed for each item; the last one is the autocorrelation of the error term.

Table 3 – Estimation Results for PADS

	Lamda	Share	Income elas	Price elas	Trend	Err%	Rho
Items sensitive to prices							
Food	0.12	0.147	0.07	-0.33	0.00	0.8	0.36
Non alc beverages, Coffee, Tea and Cocoa	-0.09	0.011	0.83	-0.33	-0.02	2.1	0.66
Alcoholic Beverages	0.49	0.008	0.17	-0.71	-1.18	8.5	0.91
Clothing	-0.27	0.067	0.67	-0.53	-0.07	2.8	0.71
Footwear and Repair	-1.90	0.018	0.75	-0.35	0.06	1.9	0.37
Rents	0.34	0.020	0.30	-0.56	-0.47	2.6	0.65
House maintenance	0.01	0.013	0.33	-0.25	-0.73	4.6	0.6
Electricity, gas, and other fuels	0.01	0.037	0.71	-0.24	0.00	3.4	0.34
Furniture	-0.21	0.036	1.82	-0.55	0.00	2.1	0.6
Household Linen	-0.10	0.005	0.86	-0.60	-0.34	8.3	0.53
Kitchen and Household appliances	-0.58	0.012	1.31	-0.47	0.21	2.6	0.47
China, Glassware and Tableware	0.02	0.007	1.43	-0.64	-0.47	3.2	0.68
Household and garden utensils	-0.16	0.004	1.66	-0.60	-0.30	3.8	0.63
Other NonDurables	0.34	0.025	1.19	-0.56	-0.39	2.4	0.74
Vehicles	1.00	0.045	1.52	-0.79	-0.52	4.7	0.45
Operation of Motor Vehicles	0.88	0.081	1.02	-0.79	0.03	4.1	0.54
Public Transportation	-0.17	0.019	1.01	-0.25	0.01	1.7	0.43
Telephone and communication equipment	1.39	0.007	1.71	-0.67	0.53	9.6	0.66
Telephone and communication services	0.47	0.020	1.61	-0.37	0.34	9.2	0.92
TV, Radio, Photo, Computers	-1.17	0.010	1.67	-0.91	0.38	6.0	0.84
Other recreational durables	-0.12	0.004	1.72	-0.67	-0.96	4.1	0.65
Recreational equipment, flowers, plants, pets	-0.04	0.012	1.02	-0.66	0.17	2.1	0.47
Recreational and cultural Services	1.08	0.023	1.67	-0.87	0.02	2.4	0.16
Books, newspaper	0.62	0.016	1.07	-0.18	-0.46	8.0	0.89
All inclusive holidays	1.00	0.002	1.45	-1.80	0.38	5.5	0.56
Bar and Restaurants	0.97	0.045	1.45	-1.29	-0.08	3.1	0.57
Hotels & motels	0.41	0.015	1.35	-1.08	0.27	5.1	0.55
Personal Care equipment	0.55	0.027	1.36	-1.05	-0.04	3.7	0.53
Personal care items n.e.c.	0.65	0.013	0.73	-1.49	-0.04	3.4	0.71
Insurance	0.48	0.016	1.90	-0.29	0.37	8.6	0.71
Financial Services	0.67	0.026	0.63	-0.60	-0.05	6.4	0.39
Other Services n.e.c.	0.88	0.011	1.74	-1.09	0.36	1.9	0.55
Items insensitive to prices							
Tobacco	0.00	0.018	0.08	0.00	-1.28	5.22	0.81
Tenant Occupied Rent	0.00	0.111	1.23	0.00	-0.51	2.65	0.87
Water and other household services	0.00	0.019	1.42	0.00	-0.07	4.9	0.53
Drug Preparation, Sundries and orthopedic equi	0.00	0.016	2.40	0.00	0.44	9.4	0.84
Physicians, Dentists, Other Medical prof	0.00	0.012	1.58	0.00	0.34	6.83	0.87
Hospitals, Nursing Homes	0.00	0.006	0.65	0.00	-0.01	8.25	0.78
Postal services	0.00	0.002	0.42	0.00	-0.01	6.62	0.69
Education	0.00	0.010	1.42	0.00	-0.18	4.95	0.55
Social services	0.00	0.006	1.06	0.00	0.24	4.82	0.4

First of all, the estimated elasticities have signs and magnitudes that are coherent with the expectations regarding the consumer's behavior[19]. The procedure of estimation was performed using the [8] for 'sensitive' items, i.e. commodities that are price elastic (non zero elasticity with respect to prices), and a reduced form of [8], without the price component, for 'insensitive' items.

For the items in the 'Food, Non Alcoholic Beverages, Tea and Coffee' group the own elasticities are all much less than one in absolute value. This result indicates that all these goods are inelastic commodities. The μ of this group is 0.2 and the results in terms of cross price elasticities suggest a complementarity between the category of 'Food' and the category of 'Beverages'. The difference here is the elasticity with respect to income: for 'Food' the result is very close to zero (less than 0.1); for 'Non Alcoholic Bev' the result is very close to one (0.83). Alcohol Beverages is not included in any specific group: the results of the estimation give us the representation of an elastic good with respect to price that tend to reduce his role in the consumption pattern with an increase in income. The time trend indicates negative path for this kind of goods. Tobacco is considered 'insensitive' and so we have just the income elasticity (very low).

Another group is 'Clothing, and Accessories'. It includes also Footwear and Repair; results in terms of own price elasticities indicate that 'Clothing' is an elastic commodity (-0.53), more than 'Footwear' (-0.35). The result for the first commodity is very similar to that one estimated by Almon. The second one is totally different both in terms of price and income elasticity. The cross price elasticity indicate a substitutability for these two categories.

With respect to the original general version of PADS [8] that included disposable income (proxied by the total amount of consumption) and relative prices it is possible to include also other variables. For some durables the system widens to include also the lagged stock of that commodity. The idea here is that if two persons have the same income and face the same price and everything else is the same, the decision of buying could be different because the first person bought last year that durable goods and the second one didn't buy it. A commodity estimated using also the stock is the 'Vehicles'. For this item we need to consider also some dummy variables to control for some specific events (1997, 1998 National Government introduced incentives to buy a new car). The result obtained indicate that 'Vehicles' are elastic with respect to their own price and they are very income-growth sensitive (1.52 is income elasticity).

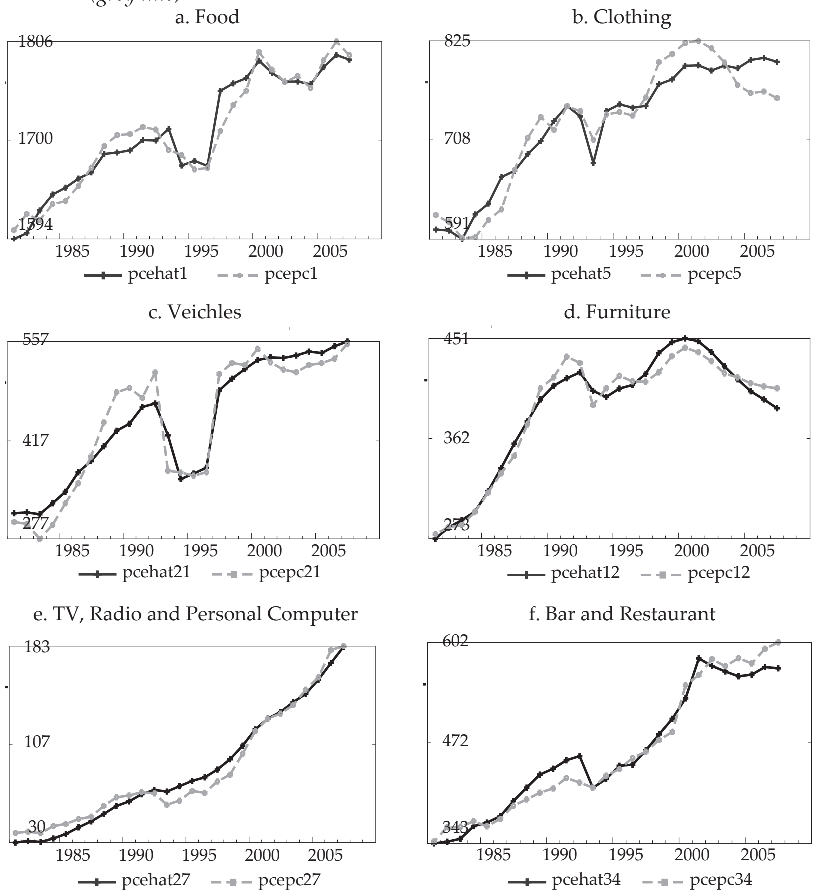
For other durables, we didn't obtain good results using the lagged stock as explanatory variable. In the specification of the 'House Furniture', for example, it was introduced the real interest rate. The reason here is to take

[19] In the estimation process was immediately clear that sometimes data produced as a mixture of different sources created problem with the sign of the parameters. This is way it was necessary to introduce a system of 'soft constraints' able to tell the system what is plausible and what is not.

into account the development of credit for household consumption that Italy has registered in the last ten years. The estimation gives an income elasticity very high (1.82) and a relative high, in absolute term, own price elasticity. The same specification was used for other durables as 'TV, Radio, and Personal Computers'. The own price elasticity is very high (-0.91) and the same is true also for income elasticity. The error committed for this item is approximately 6.0% but the result is linked to the rapid growth of the amount of consumption (the error was low in absolute term in the past but it was very high in percentage to the effective figures).

A very good test for these estimation is to look at the graph to see whether the system is good enough to fit historical data using the parameters obtained in the estimation process.

Graph 3 – Estimation Results for some commodities. Fitted values (black line) vs actual value (grey line)



Our expectations for an high price elasticity in the service sectors are fulfilled by the estimation results obtained. In particular, for 'Bar and Restaurant' the income elasticity is relatively high (1.45) and the price sensitivity is high in absolute term (-1.29); The error committed is relatively low (3.0%). The same is true also for 'Hotels, and Motels'.

As the graph 3 shows some items have some problem in the last period. The fitting is not very good for 'Clothing' in the last ten years, some problems also for 'Bar and Restaurant' in the last four years. In order to consider this bad performances we have also an estimation of the autocorrelation in the error terms. Using this parameters we can introduce in DANTE a rho-adjustment procedure, specific for each different goods or service, that is able to change the values estimated in order to consider the error committed in the last year observed.

Combining these results with that obtained with the Aggregate Equations DANTE is able to consider the evolution of consumption patterns in the next future for the italian regions included in the model. Perhaps!!!

Conclusions and further extensions

This paper shows some progress for a new Italian model inspired by the INFORUM approach. The matter under discussion is the module for 'resident consumption behavior' inside the general model called DANTE and so, due to the pragmatic orientation of the work, the main task of the contribution is to describe the strategy adopted. The consumption module is composed of two blocks: the first one, at an aggregate level, is based on the Life Cycle Hypothesis and it is used to obtain the total amount of resident consumption for each region; the second one is a system of equations oriented to produce an estimation of price and income elasticities for many different items at national level.

The specification adopted for the aggregate analysis indicates a positive relationship between the level of wealth and the level of consumption in the long-run, as we expected, and a positive relation of expenditure with the level and the variation of disposable income. The movement observed in the real interest rate has negative effects on aggregate consumption. That is the result for each region analyzed. The second step, using a disaggregated approach, gives a set of results in terms of own price elasticity for 41 commodities coherent with expectations both for the sign and magnitude of the parameters estimated. And so, services have a relatively high elasticity, food has a relatively low reactivity with respect to price, durables goods have an higher price-elasticity and income elasticity respect to non durables goods. The real interest rate has a minor role and it is relevant just for few durables.

The 'pure-LCH' could explain these relationships but it is not the only one (the behavior of consumer could be explained also considering bequest motivation) The aggregate specification is the same in both cases and aggregate data used in this work are not sufficient to understand what is the effective reason at heart of the decision. But the goal of the work is not to answer this important theoretical question; our focus is just on the simulation of consumption path observed in the past in order to obtain a useful structural equation for forecasting. The aggregate equations are able to reproduce resident consumption patterns at regional level with an high level of precision.

The actual complexity of consumption behavior could not be correctly interpreted just using aggregate data because heterogeneity is not considered in a model that hypothesizes the 'representative agent', as the traditional macro-models hypothesize. To deal with this problem we need an interaction between the macro and micro level where the decision on labor supply, the decision on saving, the decision on the composition of portfolio is modeled at the level of each elementary unit (household) and the aggregate results of this step would be integrated in the macro model. This structure would be very useful to correctly evaluate the stabilization power of different policy option because the micro-macro model would consider more precisely the non-linear relationship among different aggregate (i.e. taxes collected and the value of production; wealth hold by households and liquidity constraints in different point of the economic cycle). The idea to link the macro model with a microsimulation tool is the core of a long term project we want to complete. In the short run, a preliminary step is to exploit entirely the flexibility supplied by PADS. The original version of the Demand System presented by Almon has been extended in order to consider demographic factors as, for example, the role of the 'age structure of population' that could be relevant for different kind of consumption items, or the role of different cohort with different preferences. An elderly couple spends more on drugs than a young couple; teenagers in 1990 have a pattern of consumption different respect to teenagers today (i.e. the consumption of cell phones). It is possible to introduce in PADS a system of weights in order to change the absolute level of population. In this way each item would be explained using a population that is different thanks to demographic factors that could be influent in the consumption behavior (Bardazzi, Barnabani 2001; Devine, 1983; Chao, 1991). Cross-section data on consumption decision of every household included in the survey is the starting point to calculate weighted populations. Difference in the consumption of elementary units (households) are linked also to the income distribution among households and PADS gives us the opportunity to introduce it in the estimation.

In this way we think to build a tool helpful to analyze the evolution of our social and economic system in the long term considering also the distributional consequences of policies.

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Appendix

Nsec	Title	Group	Sub-group	Sensitive (included in the price component)
1	Food	1	0	1
2	Non alc beverages, Coffee, Tea and Cocoa	1	0	1
3	Alcoholic Beverages	0	0	1
4	Tobacco	0	0	0
5	Clothing	2	0	1
6	Footwear and Repair	2	0	1
7	Rents	0	0	1
8	Tenant Occupied Rent	0	0	0
9	House maintenance	0	0	1
10	Water and other household services	0	0	0
11	Electricity, gas, and other fuels	0	0	1
12	Furniture	3	3	1
13	Household Linen	5	0	1
14	Kitchen and Household appliances	3	3	1
15	China, Glassware and Tableware	5	0	1
16	Household and garden utensils	5	0	1
17	Other NonDurables	0	0	1
18	Drug Preparation, Sundries and orthopedic equi	0	0	0
19	Physicians, Dentists, Other Medical prof	0	0	0
20	Hospitals, Nursing Homes	0	0	0
21	Vehicles	4	1	1
22	Operation of Motor Vehicles	4	1	1
23	Public Transportation	4	0	1
24	Postal services	0	0	0
25	Telephone and communication equipment	6	0	1
26	Telephone and communication services	6	0	1
27	TV, Radio, Photo, Computers	3	0	1
28	Other recreational durables	7	0	1
29	Recreational equipment, flowers, plants, pets	7	0	1
30	Recreational and cultural Services	7	2	1
31	Books, newspaper	7	2	1
32	All inclusive holidays	8	0	1
33	Education	0	0	0
34	Bar and Restaurants	8	0	1
35	Hotels & motels	8	0	1
36	Personal Care equipment	9	0	1
37	Personal care items n.e.c.	9	0	1
38	Social services	0	0	0
39	Insurance	10	0	1
40	Financial Services	10	0	1
41	Other Services n.e.c.	0	0	1

J. Werling
R. Horst

Defense Spending Cuts: The Impact on Economic Activity and Jobs

Introduction

The Budget Control Act of 2011 (BCA)[1] established two mechanisms that could result in large cuts to the U.S. federal defense budget compared to previously projected defense spending. The cuts will include reductions in military and civilian personnel, the cancellation of planned procurement of weapons programs and other equipment, and declines in expenditures for operations and maintenance due to the withdrawal from wars in Iraq and Afghanistan.

We consider the effects of these changes on the U.S. economy as a whole, on the industrial composition of the country, and the effects on each state. The analysisis conducted within the context of existing and expected economic conditions and current discussions concerning the reduction of federal budget deficits over the next decade. We use Inforum modelsof the U.S. economy to determine the economic and employment impacts of specific alternative scenarios for federal defense spending from 2012 to 2022. Over the short term, such reductions will result in lost domestic production and jobs, especially with the U.S. economy currently operating wellbelow production potential and full employment.

This work was written with support by the National Association of Manufacturers. The full report, Werling and Horst (March 2012), *Defense Spending Cuts: The Impact on Economic Activity and Jobs*, may be found at www.nam.org/~/media/6C787C12117F49D1BDA2B6526A14DC2E.ashx. For further information concerning this report, please contact: Jeffrey Werling, Inforum-University of Maryland, at (301) 405-4607 or werling@econ.umd.edu. Slides for the 2012 Inforum World Conference presentation by Ronald Horst are available at www.inforum.umd.edu.

[1] Pub.L. 112-25, S. 365, 125 Stat. 239, enacted August 2, 2011.

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The basic methodology is to establish a baseline projection of the U.S. economy from 2012 to 2022 with a U.S.macroeconomic-interindustry model. This “status quo” baseline contains trajectories for federal spending in line with Congressional Budget Office (CBO) projections before adjustments are made for the BCA. Next, we use CBO estimates of the BCA effects on defense expenditures to develop two alternate simulations that incorporate different trajectories for such spending. Compared to the baseline simulation, these alternate scenarios illustrate the economic and employment impacts of lowered defense expenditures. The results are computed at both the industry and macroeconomic levels. Employment impacts by industry also are estimated across states to determine the regional distribution of the national effects. This analysis allows us to evaluate the benefits of these policies, particularly in terms of any reduction of federal deficits, and the cost in terms of production, jobs, and income.

Defense Spending Policy and Assumptions

The first mechanism of the BCA (BCA-1) imposes dollar-value caps on total discretionary federal spending, with some exceptions including the Overseas Contingency Operations (OCO) that cover the operations in Iraq and Afghanistan. The actual distribution of these cuts across different categories of discretionary spending (e.g., defense vs. nondefense) is not specified in the legislation.

In addition, the BCA created a Joint Committee of Congress (the “Super Committee”) to identify at least $ 1.2 trillion of additional deficit reduction by November 21, 2011. The Super Committee was unable to agree on a deficit reduction package. As a result, as required under the BCA, automatic reductions in discretionary spending (sequestration) will begin on January 1, 2013. Sequestration (BCA-2) will impose automatic across-the-board cuts of $ 1.2 trillion over 10 years split equally between defense and nondefense (discretionary and mandatory) spending.

The January 2012 *Budget Outlook* of the Congressional Budget Office (CBO) provides the basis for framing the defense spending assumptions. These pertinent figures are summarized, on an outlay basis, by Table 1. In particular, we employ figures from Table 3.5 in “CBO’s Projection of Discretionary Spending Under Selected Policy Alternatives”. Here the CBO provides a hypothetical trajectory for defense outlays assuming that they grow from 2012 levels at the rate of GDP inflation. We assume that this is the status quo baseline projection that would occur without the imposition of the BCA-1 and BCA-2. Under the Status Quo, defense outlays would total $ 8.1 trillion from FY2012 through FY2022.

CBO also provides a projection for defense outlays assuming that the BCA-1 expenditure caps take effect but that the BCA-2 sequestrations do not occur. The forecast is $ 7.8 trillion of defense expenditures across FY2012 to FY2022. CBO estimates that these BCA-1 caps will reduce defense expenditures by $ 272 billion over the eleven years. The February 2012 Department of Defense (DoD) Future Years Defense Plan (FYDP), which provided spending proposals through FY2017, generally corresponds to this trajectory, showing that the currently proposed budget of the Pentagon adheres closely to the spending caps established by the BCA-1.

Table 1 – U.S. Defense Outlays, Fiscal Year Basis
Billions of Dollars

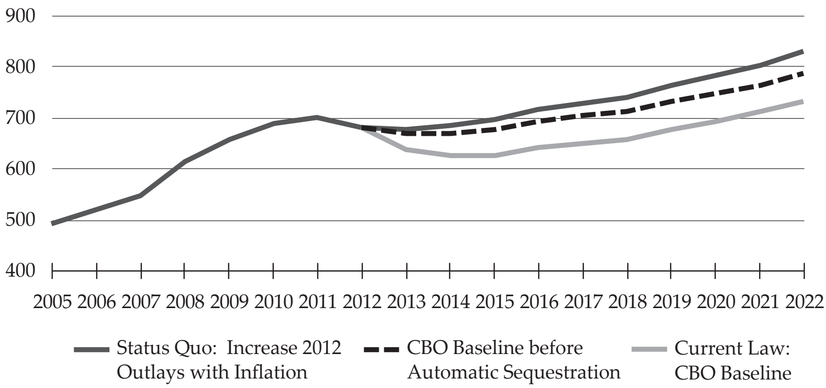
	Actual 2010	Actual 2011	Budget 2012	Projection 2013	2014	2015	2016
Status Quo: Increase 2012 Outlays with Inflation	689	700	680	679	687	698	718
CBO Baseline before Automatic Sequestration			680	669	671	679	695
Effect of BCA1 caps compared to Status Quo				10	16	19	23
Current Law: CBO Baseline			680	636	625	627	642
Effect of BCA2 sequestration				33	46	52	53
Effects of BCA1 and BCA2 compared to Status Quo				43	62	71	76

	2017	2018	2019	2020	2021	2022	Total 2012-2022
Status Quo: Increase 2012 Outlays with Inflation	729	741	765	785	805	831	8.118
CBO Baseline before Automatic Sequestration	704	712	733	749	765	789	7.846
Effect of BCA1 caps compared to Status Quo	25	29	32	36	40	42	272
Current Law: CBO Baseline	649	658	679	695	711	734	7.336
Effect of BCA2 sequestration	55	54	54	54	54	55	510
Effects of BCA1 and BCA2 compared to Status Quo	80	83	86	90	94	97	782

Source: Congressional Budget Office, Budget Outlook, January 2012. Table 3.5, pages 74-75.

Finally, CBO's January 2012 "current law" budget projection assumes that both the BCA-1 expenditure caps and the BCA-2 sequestrations occur as specified. It assumes that defense spending will total $7.3 trillion from FY2012 to FY2022. By comparing this to the budget with only BCA-1 caps, we see that automatic sequestration is slated to remove $510 billion from the budget. Together, the BCA-1 and BCA-2 measures are assumed to cut $782 billion from defense expenditures from FY2012 to FY2022, compared to the status quo baseline of defense expenditure. We will use this projection for the BCA-2, or "current-law" scenario. Figure 1 displays the three trajectories.

Figure 1 – U.S. Defense Outlays, Fiscal Year Basis (Billions of dollars)



Since most economic data and modelsare developed witha calendar year basis, the spending assumptions of Table 1 were converted from a fiscal year to a calendar year basis using a simple formula that allocates three fourths of fiscal year spending to the same calendar year and one quarter of fiscal year spending to the previous calendar year.

Using the baseline GDP price index, we calculate defense spending in real terms, in 2011 dollars. This perspective shows a steep initial fall in real expenditures from 2012 to 2014 because of reduced war spending in the status quo baseline. Compared to its level in 2011, baseline real spending is 6 percent lower by 2014. From that point through 2022 real growth in the baseline is negligible.

For each alternative, the BCA-1 and BCA-2 measures force even larger real cuts in 2013 and 2014, and, for the BCA-2 case, in 2015 as well. For CBO's current law projection, real defense spending will be 16 percent lower in 2015 compared to 2011. Once these initial reductions are completed, however, real expenditures are more or less constant through 2022.

Methodology and Models

We use model-based simulation to compare the performance of the U.S. economy under the three federal defense expenditure trajectories specified in Table 1.In the first case, total nominal defense expenditures are assumed to be equal the value specified in the first line of Table 1 (adjusted for the difference between the CBO budget accounting and the National Income and Product (NIPA) accounting and changing fiscal years to calendar years). After imposing these assumptions, the *LIFT*model is otherwise calibrated to Inforum's most recent U.S. economic forecast. This becomes the "status quo baseline" projection. The first alternative scenario (BCA-1) incorporates the lower expenditures levels stipulated by the hard budget caps of the BCA. The defense-spending trajectory in this scenario roughly is equivalent to the Administration's current budget proposal. The second alternative (BCA-2) adds to the cuts under BCA-1 by including the automatic sequestration that was triggered by the failure of the Joint Congressional Committee created by the BCA.

The baseline projection reflects an economy slowly recovering from the deep recession of 2008 to 2009. The tepid growth of 1.7 percent in 2011 accelerates only slightly to 2.4 percent in 2012. Recovery quickens from 2013 through 2018, with GDP growing over 3.0 percent in each year. However, the economy remains below potential output until 2018 when the unemployment rate registers 5.3 percent. After 2018, GDP growth is between 2.0 and 2.5 percent.

The distribution of defense expenditures across the defense categories (personnel, aircraft, fuel, services, etc.) are set to published NIPA history through 2011. Expenditures then are projected in both nominal and real terms through 2016 using figures for broad Department of Defense (DoD) budget categories such as Compensation, Operations and Maintenance, Procurement, and Research and Development, taken from the National Defense Budget Estimates.[2] Military and Civilian Defense employment also are taken from this source. After 2016, the distribution across categories is projected according to historical trends.

As a proportion of baseline spending, the nominal reductions in the BCA-1 scenario start at 1.6 percent in 2013 and reach a maximum of 4.8 percent in 2022. For the BCA-2 scenario, defense expenditures are reduced by 6.7 percent in 2013, reach 10.6 percent by 2016, and increase to 11.1 percent in 2022.

For the alternative scenarios (BCA-1 and BCA-2), spending relative to the baseline for each broad category (compensation, equipment and durable, etc.) and employment (federal defense civilian and military) is re-

[2] Office Of The Under Secretary Of Defense (Comptroller), *National Defense Budget Estimates For FY 2012*, Washington D.C.: March 2011.

duced by the same proportion in nominal terms. For example, purchases of equipment and durables make up around 18 percent of spending and therefore experience 18 percent of the cuts. Personnel compensation, both military and civilian, makes up between 40 to 45 percent of expenditures throughout the horizon. Consequently, compensation takes 40 to 45 percent of the cuts. Military and civilian employment levels are cut by the corresponding percentage. In other words, savings are accomplished by reducing employment, not by cutting wages and benefits rates relative to the baseline.

These data and projections are employed in the Inforum national model and regional model to produce macroeconomic-interindustry forecasts of the national economy and state-level forecasts of income and of employment by industry. These models are described below.

The LIFT Model

The Inforum Long-term Interindustry Forecasting Tool (*LIFT*) is a unique 97-sector dynamic general equilibrium representation of the U.S. national economy. It combines an interindustry input-output (IO) formulation with extensive use of regression analysis to employ a "bottom-up" approach to modeling the economy. The model works like the actual economy, building the macroeconomic totals from details of industry activity, rather than distributing predetermined macroeconomic quantities among industries.

This bottom-up technique possesses several desirable properties for analyzing the economy. First, the model describes how changes in one industry affect related sectors and the aggregate quantities. Second, parameters in the behavioral equations differ among products and industries. Third, the detailed level of disaggregation permits the modeling of prices by industry, allowing one to explore the causes and effects of relative price changes. Another important feature of the model is the dynamic determination of endogenous variables. *LIFT* is an annual model, solving year by year, and incorporates key dynamics that include investment and capital stock formation. Parameter estimates for structural equations largely are based on time-series regressions, thereby reflecting the dynamic behavior of the economic data underlying the model. Therefore, model solutions are not static but instead project a time path for the endogenous quantities. This allows us to examine both the ultimate economic impacts of spending policies and the dynamics of the economy's adjustment process over time.

Despite its industry basis, *LIFT* is a full macroeconomic model, with macroeconomic variables calculatedto be consistent with the underlying industry detail.This macroeconomic "superstructure" contains key functions for household savings, interest rates, exchange rates, unemployment, taxes, government spending, and current account balances. Like dynamic macroeconometric models, this structure is configured to make *LIFT* exhibit

"Keynesian" demand-driven properties over the short-run but neoclassical growth characteristics over the longer term. Especially in an economy with substantial slack, monetary and fiscal policies significantly affect the level of output in the short-to-intermediate term. Over the long term, however, supply forces – available labor, capital, and technology – will determine the level of aggregate output, and the I-O structure at the model's core, together with labor productivity and investment equations, tie industry output to the factors of production and technological development.

The interindustry framework underlying the model is composed of five blocks: final demand, supply, factor income, prices, and the accountant. The first block of *LIFT* uses econometric equations to predict the behavior of real final demand (consumption, investment, imports, exports, and government spending). The components are modeled at various levels of detail. For example, aggregate consumption is the sum of 92 consumption products. Demand by product, with product sectors consistent with the A matrix, is determined using bridge matrices to convert final demand to the commodity level. Following Wilson (2001), this equation is specified as:

$$f_{97\times1}={H^c}_{97\times92}c_{92\times1}+{H^{eq}}_{97\times55}eq_{55\times1}+{H^s}_{97\times19}cs_{19\times1}+i_{97\times1}+x_{97\times1}-m_{97\times1}+g_{97\times1}$$

where*H* represents a bridge matrix for the various components: consumption, equipment investment by purchasing industry, expenditures by type of structures, inventory change, exports and imports, and government spending.

In the supply block, these detailed demand predictions then are used in an input-output production identity to generate real gross output demanded:

$$q = Aq + f$$

where*q* and *f* are vectors of output and final demand, respectively, each having 97 elements, and where A is a 97x97 matrix of input-output coefficients. Input-output coefficients and the bridge matrix coefficients vary over time according to historical trends evident in available data, and, in some cases, using assumptions about how technology and tastes might develop in the future (Almon 2008).

Commodity prices are determined in a similar fashion. In the factor income block, econometric behavioral equations predict each value-added component (including compensation, profits, interest, rent, and indirect taxes) by industry. Labor compensation depends on industry-specific wages that are determined by industry-specific factors as well as overall labor conditions. Profit margins are dependent on measures of industry slack (excess supply or demand) and, for tradable sectors, international prices. Depreciation depends on capital stock. Indirect taxes and subsidies are imposed, in most cases, through exogenous ad-valorum rates on overall nominal output.

The industry value added levels are allocated to production commodities using a make matrix. Then the fundamental input-output price identity combines value added per unit of output with unit costs of intermediate goods and services to form an indicator of commodity prices:

$$p' = p' A + v'$$

where$p$ and v have 97 elements to represent production prices and unit value added, respectively. This identity ensures that income, prices, and output by sector are directly related and are consistent. In turn, relative prices and income flows are included as independent variables in the regression equations for final demand, creating simultaneity between final demand and value added.

As noted above, *LIFT* also calculates all of the major nominal economic balances for an economy: personal income and expenditure, the government fiscal balance (at both the federal and state and local government levels), and the current account balance. It also contains a full accounting for population, the labor force, and employment. This content is important for building alternative scenarios because it supportsconsistency between economic growth determined on the product side with the inflation and income components computed on the price side.

The *LIFT* model possesses a flexible structure for performing alternative scenarios. Exogenous assumptions can be modified easily, and endogenous variables or equation structures can be altered at the industrylevel. Particularly relevant to this project is that *LIFT* contains twenty-five specific expenditure categories for defense spending as defined by the National Income and Product Accounts (NIPA) Table 3.11. The quantities for each of these variables are specified exogenously for each simulation of the *LIFT* model. Thus, they are the levers we use to impose different assumptions for defense spending.

These detailed defense expenditures are converted to final demand by sector using a "bridge matrix" constructed with data derived from the benchmark and annual input-output tables produced by the Bureau of Economic Analysis (BEA). For instance, defense expenditures on aircraft and missiles are converted mostly to direct final demand of the aerospace industry, though some direct final demand is allocated to sectors such as metal products, search and navigation equipment, and wholesale trade. On the other end of the spectrum, expenditures for other durable equipment are spread across final demand for a number of producing industries.

STEMS - The State Employment Modeling System

The Inforum STEMS (State Employment Modeling System) model provides projections of employment, output, and earnings for 65 industries, for 50 states and the District of Columbia. STEMS relies onexogenous projections at the national level that first were developed with the Inforum *LIFT* model of the national economy.Although aggregate activity in each STEMS forecast is forced by designto beconsistentwith the national model, much of the state-level activity is endogenous.

STEMS starts with the national projection of the level of employment and output by industry. It relates the employment by industry in each state partly to national employment forthat industry and partly to the level of personal income in that state. Industries that are assumed to serve mainly national markets are called national or "basic" industries, and industries that mainly serve local markets are "non-basic" industries. The degree to which an industry is basic (national in scope) is defined by a coefficient between 0 and 1.

State shares of employment in an industry thatis basic are determined by a number of factors. An industry may be established in a state due to natural resource availability, infrastructure, availability of skilled labor, etc. For these reasons, the states shares are likely to change slowly, since the relative strength of these factors in each state changes slowly. However, other factors also are at play, such as relative wage rates in different areas or agglomeration effects due to growth of clusters of industries in a particular location. Once employment has been calculated, real output is derived using national ratios of output to employment by industry. This assumes that labor productivity for a given industry is the same in each state. Although this assumption is not true, there are no data available to identify different output to labor ratios for a given industry by state.

The STEMS historical data includes earnings and employment for each industry by state. STEMS calculates earnings by industry based on employment levels. STEMS moves the state earnings-to-employment ratios forward in time by the movement of the ratio of income (proprietors' income plus labor compensation) to employment in the forecast of the national model.

The next step is to calculate total personal income in each state. Personal income is formed as a function of the following components: 1) total earnings (wages, salaries, and proprietors' income), 2) transfer payments, established by regression analysis, 3) dividends, interest, and rental income, 4) contributions for social insurance, and 5) a residence adjustment for the net income that is earned in another state by residents of a given state. Personal incomeis an important influence on employment and output in a given state, particularly in the industries that have a basic coefficient less than 1.

After the model has converged, disposable income by state is calculated, based on the ratio of disposable income to personal income in the national model. The difference between personal income and disposable income consists of personal current taxes. From disposable income, total personal consumption is calculated usingthe ratio of personal consumption to disposable income. The difference between disposable income and personal consumption consists of personal savings, personal interest payments to business, and personal transfer payments to government, business, and rest of world. Next, total personal consumption is divided into personal consumption by industry using shares from the national model.

For the current project we also used data supplied via information from the publication *Projected Defense Purchases: Detail by Industry and State: Calendar Years 2010 Through 2016.*[3] Information on the direct and indirect defense output by industry and by state was used to modify the state-industry matrices of the STEMS model to better determine the location changes of direct and indirect (upstream) job losses resulting from lower defense purchases.

Results – The Economic and Employment Impacts of Defense Budget Cuts

National-levelmodeling results are provided both forthe macroeconomy and for the industries. Table 2 shows summary macroeconomic results for each of the two alternative scenarios from 2012 through 2022. For each concept, the line items indicate the deviation from the baseline in various metrics. In both alternatives, real defense expenditure is reduced progressively from 2012. Compared to the baseline, real defense spending in the BCA-1 scenario is 2.5 percent lower in 2015, and the reduction is almost twice as large at 4.6 percent by 2022.

In a dynamic model such as *LIFT*, the production, income, and employment responses to an expenditure shock will vary over time. Moreover, they also will be sensitive to the phase of the business cycle. The current economic environment is characterized by unemployment levels over 8 percent and historically low interest rates, including a monetary policy rate that essentially is zero. Therefore, because product and employment demand elsewhere in the economy is weak, additional and sharp reductions in government spending will trigger relatively large and lingering reductions of GDP and employment.

Table 2 shows that the reduction in GDP from the baseline will be 0.2 percent for BCA-1 and 0.8 percent for BCA-2 in 2014.The initial real and nominal GDP multipliers are around 2.0.Differences in aggregate employment are also displayed in thetable. In both scenarios, the peak job loss also occurs in 2014. For BCA-1 we see a loss of 261,000 private sector jobs and 34,000 manufacturing jobs in 2014, compared to the status quo baseline. The corresponding job loss in 2014 for BCA-2 is 1,010,000 total jobs and

[3] Economic and Manpower Analysis Division (EMAD), Cost Assessment and Program Evaluation (CAPE) of the Office of the Secretary of Defense (OSD), *Projected Defense Purchases: Detail By Industry and State: Calendar Years 2010 Through 2016,* November 2011.

130,000 manufacturing jobs. Adding the reduction of over 200,000 federal civilian and military jobs in 2014, the total job loss given both types of BCA expenditure reductions is over 1.2 million jobs by 2014. Figure 2 displays the effects of BCA-1 and BCA-2 on total U.S. employment.

Table 2 – Macroeconomic Summary of Simulation Results

	2012	2013	2014	2015	2016	2018	2020	2022
Real federal defense expenditures (Percent)	-0.3	-1.4	-2.1	-2.5	-2.9	-3.6	-4.2	-4.6
	-1.3	-5.9	-8.0	-9.0	-9.5	-10.1	-10.5	-10.6
Real Gross Domestic Product (Percent)	0.0	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1
	-0.1	-0.6	-0.8	-0.7	-0.6	-0.3	-0.2	-0.2
Real Disp Income, billions2005$ (Percent)	-0.04	-0.19	-0.27	-0.26	-0.23	-0.11	-0.04	0.02
	-0.14	-0.71	-1.03	-0.97	-0.78	-0.25	0.08	0.22
Real GDP to Defense Multiplier	2.37	2.47	2.12	1.76	1.40	0.85	0.72	0.55
	1.94	2.22	2.15	1.80	1.40	0.75	0.55	0.41
Employment								
Private Sector Employment (thousands of jobs)	-43	-210	-261	-236	-188	-80	-59	-18
	-142	-755	-1010	-878	-611	-148	-15	74
Manufacturing Employment (thousands of jobs)	-4	-20	-34	-33	-28	-14	-12	-11
	-14	-75	-130	-130	-99	-39	-24	-18
Govt Defense Employment (thousands of jobs)	-8	-37	-53	-61	-70	-84	-98	-105
	-35	-152	-201	-222	-229	-236	-241	-243
Total Employment (government + civilian) (thousands of jobs)	-51	-247	-314	-297	-258	-164	-157	-123
	-177	-907	-1211	-1100	-841	-385	-257	-169
Unemployment Rate (Percentage points)	0.0	0.1	0.2	0.2	0.1	0.1	0.1	0.0
	0.1	0.5	0.7	0.6	0.4	0.1	0.1	0.0
Federal Net Borrowing (-) (Baseline)	-1224	-1050	-985	-884	-856	-826	-824	-840
BCA-1 ($ Billions)	2	9	17	22	26	22	17	17
BCA-2 ($ Billions)	9	40	64	78	87	65	31	35
As percentage of GDP (Baseline)	-7.8	-6.4	-5.7	-4.9	-4.5	-3.9	-3.6	-3.3
BCA-1	0.01	0.05	0.09	0.11	0.13	0.10	0.06	0.06
BCA-2	0.05	0.21	0.33	0.39	0.43	0.29	0.12	0.12
Current Account Deficit (-) (Baseline)	-541	-592	-583	-598	-643	-756	-752	-769
BCA-1 ($ Billions)	1	6	10	10	7	4	8	11
BCA-2 ($ Billions)	4	23	35	34	18	4	18	38
As percentage of GDP (Baseline)	-3.4	-3.6	-3.4	-3.3	-3.4	-3.6	-3.3	-3.1
BCA-1	0.01	0.03	0.05	0.05	0.03	0.01	0.03	0.04
BCA-2	0.02	0.12	0.18	0.16	0.07	0.00	0.06	0.13

Line 1: BCA-1 Expenditure Caps Only (BCA-1 caps, no BCA-2 sequestration)
Line 2: BCA-2 Sequestration with BCA-1 Caps (CBO current law projection)
Alternatives are shown in deviations from status quo baseline, units as noted.

The impact on employment resulting from cuts in defense spending consists of several components: 1) direct federal defense civilian and military jobs; 2) direct job loss at contractor firms from cuts in defense purchases for equipment, supplies, and services; 3) indirect job loss at firms that supply defense contractors, for example where lower expenditures for defense aircraft mean that the material and electronics suppliers to the defense contractors will lose business and reduce employment; and 4) indirect job loss from "multiplier" or "induced" effects across the economy. Because reduced government expenditures imply a reduction in the employment of federal workers and workers in supplying sectors, disposable income falls, which in turn reduces demand in other industries, particularly consumer sectors.

Figure 2 – Change in Total Employment Relative to the Status Quo Baseline for Each Scenario (Thousands of jobs)

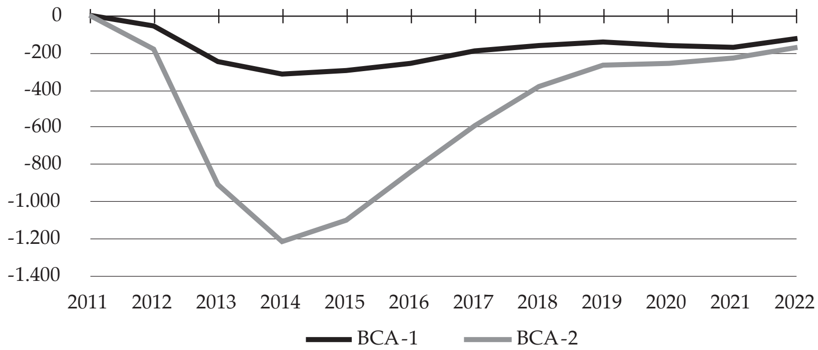
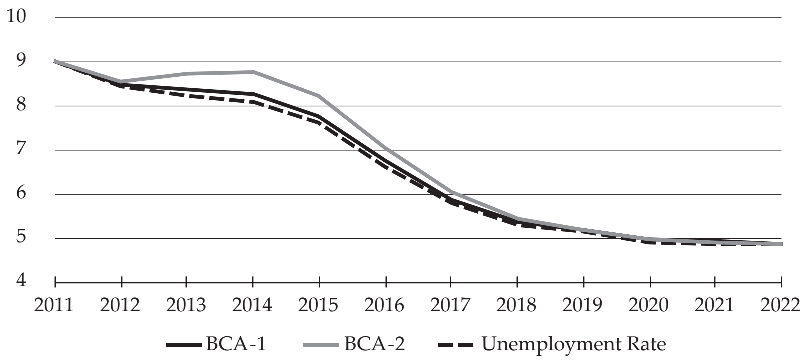


Figure 3 – National Unemployment Rate



The employment components listed in the text above are shown in Table 3 for each scenario. For the BCA-2 case, total federal employment reductions (including military and civilian personnel) rise steadily from about 200,000 in 2014 to 243,000 by 2022. These cuts are exogenous assumptions underlying the scenario. Direct employment losses at private contractors' facilities reach 125,000 by 2015 and stay around that level for the rest of the projection horizon. The indirect losses at upstream suppliers reach about 190,000 jobs. Finally, "induced" employment losses peak at over 700,000 in 2014. They then decline and even turn positive by 2017.

Initially, the decline in jobs from direct DoD employment and direct plus indirect spending leads to a decline in wages and salaries for the employees affected. This decline results in lower personal and disposable income, and thus a reduction in personal consumption. The multiplier effect also works through a chain of lower investment in equipment and structures and residential construction. Therefore, economic sectors across the economy, even sectors not related to the defense industry, will experience reductions in demand leading to job loss.

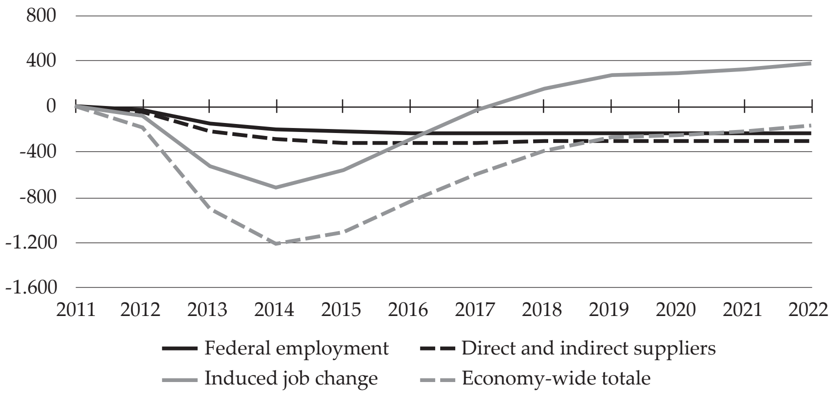
The initial multiplier effect on employment is particularly large because firms and workers are still adjusting to lower demand of recent years. However, as the economy adjusts, the impact of lower spending dissipates over time as spending is stimulated in other sectors of the economy. Interest rates are lower, which stimulates interest-sensitive durable goods consumption and equipment and building investment. Prices are lower, which provides a boost to competitiveness and leads to an increase in net exports. Government stabilizers also are at work in the form of higher transfer payments and reduced tax revenues. Eventually, workers laid off because of the initial spending shock will find jobs in other industries. These factors combine over time to boost growth so that GDP and employment tend to return to their baseline levels. Over time, the unemployment rate will return to a rate signaling "full" employment (between 5.0 and 6.0 percent). This is displayed in Figure 3. Unemployment rates drop in the baseline scenario to 6 percent in 2017 and finally hit 5 percent in 2020, but this pace slows under the BCA-1 and BCA-2 alternatives. Indeed, 2013 and 2014 rates essentially are unchanged under BCA-1, and rates rise toward 9 percent under BCA-2. By 2020, though, unemployment rates essentially are the same in each case.

Because lowered defense spending is permanent, the direct and indirect impacts on federal employment and the particular jobs in supplier sectors also arepermanent. Therefore, if employment is to return to the baseline level, the induced job impacts must turn positive. This pattern is shown in Figure 4,which shows the employment breakdown for the BCA-2 scenario. Moreover, this new job creation actually could occur for some of the very industries most hard hit by losses of defense business. For example, while the motor vehicle industry initially loses direct business with the federal government, in later years lower interest rates and enhanced consumer and private investment expenditures spur a larger level of employment in the sectors compared to the status quo baseline.

Table 3 – Decomposition of Employment Results among Federal, Direct, Indirect and Induced Changes (Thousands of jobs)

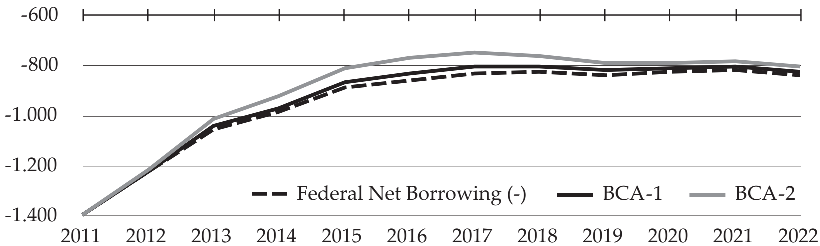
	2012	2013	2014	2015	2016	2018	2020	2022
BCA-1								
Federal employment								
Civilian	-3	-12	-17	-20	-23	-28	-32	-35
Military	-5	-25	-35	-41	-47	-56	-66	-71
Total	-8	-37	-53	-61	-70	-84	-98	-105
Private-sector employment								
Direct	-5	-22	-30	-35	-39	-44	-50	-52
Indirect	-8	-33	-46	-52	-58	-66	-75	-78
Total	-13	-55	-77	-87	-97	-110	-125	-130
Induced	-30	-155	-185	-149	-91	30	66	113
Economy-wide	-51	-247	-314	-297	-258	-164	-157	-123
BCA-2								
Federal employment								
Civilian	-11	-50	-66	-73	-76	-78	-79	-80
Military	-23	-102	-135	-148	-154	-159	-162	-163
Total	-35	-152	-201	-222	-229	-236	-241	-243
Private-sector employment								
Direct	-22	-91	-117	-125	-127	-124	-123	-120
Indirect	-33	-135	-176	-189	-191	-186	-183	-180
Total	-55	-227	-293	-314	-319	-310	-306	-300
Induced	-87	-528	-717	-564	-293	161	290	374
Economy-wide	-177	-907	-1.211	-1.100	-841	-385	-257	-169

Figure 4 – Decomposition of Employment Results for BCA-2 among Federal, Direct, Indirect and Induced Changes (Thousands of jobs)



Whether the BCA-1 or BCA-2 policies are effective depends, in part, on whether they help to reduce federal government deficits and ultimately help to stabilize or reduce the debt. Figure 5 displays the level of federal borrowing under the baseline and alternative scenarios. Under baseline policies, the deficit falls from $1.4 trillion in 2012 to about $850 billion in 2017, and it remains stable thereafter in nominal terms. In the early years, both BCA-1 and BCA-2 reduce borrowing levels slightly. BCA-1 savings are small because the program is modest, and BCA-2 savings are offset by automatic stabilizers that are triggered by the weakened economy. Borrowing under BCA-1 stabilizes around $800 billion in 2017, and average borrowing under BCA-2 settles just under $800 billion.

Figure 5 – Federal Government Borrowing



Employment Impacts by Industry

Table 4 displays employment impacts for the two alternatives. Impacts are reported as the percentage change in the number of jobs relative to baseline employment levels. By 2014,the peak year of total job losses, employment under BCA-2will beabout 0.3 percent lower in agriculture and mining and 1.5 percent lower in construction.

Under the BCA-2 scenario, manufacturing will lose about 1.0 percent, or 130,000, of its jobs in 2014 and 2015, relative to the baseline. Many of these jobs tend to be at the direct and indirect suppliers of defense equipment and supplies. Nevertheless, as the economy recovers and manufacturers swing to production for private consumption, investment, and export, the losses subside to about 0.1 percent and 18,000 jobs by 2022.This pattern varies across individual manufacturing sectors. Big direct suppliers such as those making aerospace vehicles, ships, and specialized defense equipment will not be able to replace all of their lost defense sales and the associated jobs. Other sectors that might show losses initially, such as motor vehicles and construction equipment, actually will gain jobs through time, relative to the baseline.

The largest job losses will befelt in the large nondurable sector and the transportation equipment sector. The biggest proportional reductions are within transportation equipment (aerospace, ships, and boats) and instruments (particularly the search and navigation equipment industry).

Table 4 – Employment Results by Industry

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Agriculture and Mining	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
	0.0	-0.2	-0.3	-0.2	-0.1	0.0	0.1	0.1	0.1	0.2	0.2
Construction	-0.1	-0.3	-0.4	-0.3	-0.2	0.0	0.1	0.1	0.1	0.0	0.1
	-0.3	-1.2	-1.5	-1.2	-0.6	0.1	0.4	0.5	0.4	0.3	0.2
Nondurables Manufacturing	0.0	-0.1	-0.2	-0.2	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0
	-0.1	-0.5	-0.7	-0.7	-0.5	-0.3	-0.1	0.0	0.0	0.1	0.1
Durables Manufacturing	0.0	-0.2	-0.3	-0.3	-0.3	-0.2	-0.1	-0.1	-0.1	-0.2	-0.1
	-0.1	-0.7	-1.2	-1.2	-1.0	-0.6	-0.4	-0.3	-0.3	-0.3	-0.3
Durables Materials and Products	0.0	-0.1	-0.2	-0.2	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0
	-0.1	-0.5	-0.9	-0.9	-0.6	-0.3	0.0	0.1	0.0	0.0	0.0
Non-Electrical Machinery	0.0	0.0	-0.2	-0.2	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0
	0.0	-0.2	-0.8	-1.0	-0.7	-0.2	0.0	0.1	0.0	0.0	0.0
Electrical Machinery	-0.1	-0.3	-0.4	-0.4	-0.5	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
	-0.2	-1.0	-1.6	-1.7	-1.5	-1.2	-0.9	-0.8	-0.7	-0.7	-0.6
Transportation Equipment	-0.1	-0.3	-0.5	-0.5	-0.5	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
	-0.3	-1.1	-1.8	-1.8	-1.6	-1.3	-1.0	-0.9	-0.9	-0.9	-0.8
Aerospace	-0.1	-0.5	-0.8	-0.9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
	-0.5	-2.0	-3.1	-3.4	-3.3	-3.2	-3.0	-2.8	-2.6	-2.5	-2.3
Ships & boats	-0.1	-0.5	-1.0	-0.9	-0.8	-0.8	-0.8	-0.8	-0.8	-0.9	-0.8
	-0.5	-1.4	-3.3	-3.2	-2.8	-2.4	-2.2	-2.0	-1.9	-1.8	-1.7
Instruments & Miscellaneous	0.0	-0.3	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
	-0.2	-1.0	-1.5	-1.6	-1.4	-1.1	-1.0	-1.0	-0.9	-0.9	-0.9
Search & navigation equipment	-0.3	-1.4	-2.2	-2.5	-2.8	-2.9	-3.2	-3.3	-3.6	-3.8	-3.8
	-1.3	-5.9	-8.4	-9.2	-9.3	-9.1	-8.9	-8.8	-8.8	-8.8	-8.6
Transportation, Utilities, Communication	0.0	-0.1	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
	-0.1	-0.6	-0.7	-0.8	-0.6	-0.5	-0.3	-0.2	-0.2	-0.2	-0.1
Trucking	0.0	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
	-0.1	-0.7	-0.9	-0.8	-0.6	-0.4	-0.3	-0.2	-0.2	-0.2	-0.1
Communications services	0.0	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1
	-0.1	-0.3	-0.6	-0.8	-0.8	-0.6	-0.4	-0.3	-0.2	-0.1	-0.1
Retail, Wholsesale, Restaurants	0.0	-0.2	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0
	-0.1	-0.6	-0.7	-0.5	-0.3	-0.1	0.0	0.1	0.1	0.1	0.1
Retail Trade	0.0	-0.2	-0.2	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.1
	-0.1	-0.8	-0.8	-0.6	-0.3	-0.1	0.1	0.2	0.2	0.2	0.3
Whosesale Trade	0.0	-0.1	-0.2	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
	-0.1	-0.4	-0.6	-0.6	-0.4	-0.2	0.0	0.0	0.0	0.0	0.0
Finance, Insurance, & Real Estate	0.0	-0.1	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0
	-0.1	-0.5	-0.6	-0.5	-0.3	-0.2	-0.1	0.0	0.0	0.1	0.1
Health	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	-0.1	0.0
	-0.1	-0.3	-0.5	-0.4	-0.3	-0.3	-0.2	-0.1	0.0	0.0	0.2
Other Services	0.0	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
	-0.1	-0.7	-0.9	-0.8	-0.6	-0.4	-0.2	-0.2	-0.1	-0.1	-0.1
Professional Services	0.0	-0.2	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
	-0.2	-0.8	-1.1	-1.0	-0.9	-0.7	-0.5	-0.5	-0.5	-0.5	-0.4

Line 1: BCA-1 Expenditure Caps Only (BCA-1 caps, no BCA-2 sequestration).
Line 2: BCA-2 Sequestration with BCA-1 Caps (CBO current law projection).
Alternatives are shown in percentage deviations from the status quo baseline.

Across the various service sectors, the maximum percentage loss is 1.0 percent or less. However, since these tend to be large employment sectors, they account for many lost jobs. The biggest losers in terms of the number of jobs are wholesale and retail trade, business services, and other services. Business services, which includes professional and computer programming services, and transportation services lose many jobs directly and indirectly through lower defense expenditures. Throughout services, though, and especially in trade and other services, most of the job lossesare attributable to the lower level of aggregate income. Indeed, once the shock of lower government spending subsides, trade, financial services, and other services all have modestly higher levels of employment compared to the baseline.

Employment Effects by State

The results of running the alternative simulations of *LIFT* through the STEMS state-level model are shown in Table 5, which provides the percentagechange in jobs, compared to the baseline, for the ten top states ranked by the magnitude of the job change in 2014. California sustains the largest job loss. For the BCA-2 scenario, California loses 148,000 jobs at the peak, relative to the baseline. Following California are Virginia and Texas, which lose 115,000 and 109,000 jobs, respectively.

Table 5 – Employment Results by State, Ranked by 2014 Results
Results for 10 States with Greatest Total Employment Effects

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
California	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
	-0.5	-0.7	-0.6	-0.4	-0.3	-0.1	-0.1	0.0	0.0	0.0
Virginia	-0.2	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
	-0.7	-0.9	-0.8	-0.7	-0.5	-0.4	-0.3	-0.3	-0.3	-0.2
Texas	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	0.0
	-0.6	-0.7	-0.6	-0.4	-0.2	-0.1	0.0	0.0	0.0	0.0
Florida	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
	-0.5	-0.7	-0.6	-0.4	-0.3	-0.1	-0.1	0.0	0.0	0.0
New York	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	0.0	0.0	-0.1	0.0
	-0.5	-0.6	-0.5	-0.3	-0.2	-0.1	0.0	0.0	0.0	0.1
Maryland	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
	-0.6	-0.8	-0.7	-0.5	-0.3	-0.2	-0.1	-0.1	-0.1	-0.1
Georgia	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
	-0.6	-0.8	-0.7	-0.5	-0.3	-0.2	-0.1	-0.1	-0.1	-0.1
Illinois	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	0.0	0.0	-0.1	0.0
	-0.5	-0.6	-0.5	-0.4	-0.2	-0.1	0.0	0.0	0.0	0.1
Pennsylvania	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0
	-0.5	-0.6	-0.5	-0.3	-0.2	0.0	0.0	0.1	0.1	0.1
North Carolina	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
	-0.6	-0.8	-0.7	-0.5	-0.3	-0.2	-0.1	-0.1	-0.1	-0.1

Line 1: BCA 1 - Alternative shown in percentage deviations from base.
Line 2: BCA 2 - Alternative shown in percentage deviations from base.

Conclusions

Dramatic cuts to defense spending have significant, long-lasting economic effects. Economic analysis using detailed structural models of the national and regional economy help to identify the magnitude of the effects and the dynamics of employment and production as the economy adjusts to permanent changes in the structure of demand and industry.

We find that sudden and substantial cuts to defense spending indeed can reduce federal borrowing levels, but sudden cuts do lasting damage to a weakened economy that gradually has been recovering from severe recession. Under the more austere scenario, sequestration-induced cuts alone hamper economic growth significantly. Since it also includes similar cuts of nondefense expenditures, an implementation of full sequestration could trip the economy into renewed recession.Even under the moderate scenario, recovery is likely to slow. In the longer run, the economy will regain full employment levels but with a shift in its industrial base. Fewer will be employed in government defense and in the industries that serve national defense activities, while eventually more will be employed in the production and distribution of consumer and investment goods and services.

The work summarized in this chapter was extended in October 2012 with additional support by the National Association of Manufacturers.[4] While the present work deals only with cuts to defense spending, our later work adds to the analysis both cuts to nondefense spending and changes in tax policy. In addition, the analysis considers effects of anticipated changes, such that adjustments to policy for 2013 and beyond may lead to economic consequencesin 2012.

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A multiregional structural analysis of italian regions[1]

Introduction

The main goal of this paper is to describe the changes of the Italian economic and productive structure at a sub-national level, in the 1995-2006 time span, investigating the role of spatial interdependencies among regions in the transmission of shocks.

This kind of analysis is particularly important in a dualistic economy like the Italian one. In the year 2005 the per capita GDP of the Southern regions of Italy was less than 60 per cent of that of the other regions. The gap between Centre-North and South of Italy is even wider looking at employment, poverty, education or indicators of conditions of living. Moreover, among the countries with huge regional disparities, Italy is the only one where these gaps have not reduced significantly in the long run and this phenomenon does not seem to be strictly related with the dynamic of economic growth of the whole country (Iuzzolino, 2009).

The analysis is based on the multiregional Input-Output (MRIO) model introduced by the IRPET. Important methodological improvements have

Luca Cherubini: Banca d'Italia, Florence Branch.
Renato Paniccià: IRPET (Regional Instituto for Economic Planning of Tuscany).

[1] This paper constitues an abridged and revised version of two previous papers by the same authors:

i) *A multiregional structural analysis of a dualistic economy: the italian regions over a decade. 1995-2006*, presented at 19th International Input-Output Conference, Alexandria, Virginia June 13-17, 2011;

ii) "L'interscambio commerciale tra il mezzogiorno e il centro nord: struttura e meccanismi di propagazione degli shock", forthcoming, *Seminari e Convegni n. 8, Integrazione economica tra il Mezzogiorno ed il Centro-Nord*, Banca d'Italia.

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concerned the multiregional trade flows estimate procedure, thanks to the availability of unique survey data gathered by the Banca d'Italia.

The paper is structured as follows. The first paragraph introduces the MRIO model, by explaining the method of construction, the structural form specification and by analysing the impact of interregional trade. The next two paragraphs are devoted to the structural analysis of the Italian production system, from two different points of view. Paragraph 2 describes the interdependencies between the four geographic macro areas in which Italy is typically divided, taking into account the external and interregional trade balances and the backward and forward linkages, with a spatial perspective, to the single Italian regions, in order classify them and to identify the "nodal" ones. Paragraph 3 is dedicated to some simulation exercise as paragraph 4 will contains some conclusions.

The model

The multiregional Input-Output table

The accounting structure

The accounting structure of the multiregional SUT (MRSUT) is made up by two sets of accounts: the uniregional Supply and Use Tables, and a multiregional trade flow matrix.

For each regional SUT two identities provide a link between the use and resources account and that of the formation and destination of industry output, that is:

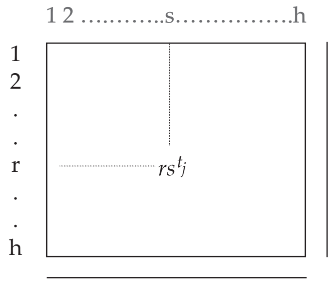
$$\underbrace{q + mr + mw}_{z} \equiv U \cdot i + df \cdot i + er + ew \qquad [1]$$

$$x \equiv i' \cdot U + i' \cdot Y \qquad [2]$$

where:

U = use matrix;
df = domestic final demand;
er = interregional export of products;
ew = foreign export of products;
q = product output;
mr = interregional import of products;
mw = foreign import of products;
x = sectoral output;
Y = industry value added matrix.

For each *j-th* product there is a trade matrix amongst the 20 (NUTS 2) regions:



The multiregional trade matrix **T** will be made up by the product trade matrices. The sum of the off-diagonal elements by row (export) and column (import) link the matrix **T** flows to the regional SUTs.

At multiregional level the identity [1] becomes:

$$q + i' \cdot \bar{R} + mw \equiv U \cdot i + DF \cdot i + \bar{R} \cdot i + ew \qquad [3]$$

where: $R \equiv \Theta \cdot vec(T)$

The MRSUT is estimated through a Generalized Least Squares (GLS) estimator as proposed by Stone, Champernowne e Meade (SCM) in Stone *et al.* (1942). The SCM balancing procedure[2], later developed by Byron (1978), is shown in details in the Appendix 1. The balancing structure of the multiregional table is mainly specified according to four groups of constraints (Appendix 2 for the accounting identities):

1. at regional level, both supply and demand of products and formation and use of output must be consistent;
2. constraints supplied from regional accounts must be fulfilled;
3. equality must be achieved between interregional flows of import and export by products at national level;
4. consistency should also be achieved regarding the national SUT, that is the sum of the regional SUT must be equal to the national one except for interregional trade.

A crucial step in balancing the multiregional table using the SCM method is the availability of unbiased initial estimates, since the presence of bias could hinder the convergence of the balancing procedure or lead to

[2] The main reasons why the SCM has been preferred to other methods has been well summarized by Round (2003). Presenting a review of the balancing methods applied to Social Accounting Matrices (rAs, Cross Entropy and SCM) the author clearly expresses his opinion in conclusion (p. 179, par.3): "... In spite of the apparent preference for the Cross Entropy method by many compilers of SAMs, the Stone Byron method (possibly extended to include additional constraints) does seem to have some advantages over alternative methods. In particular, it allows us to incorporate judgement on the relative reliability of data sources and it is therefore closer to the spirit of the problem at hand".

final values of a positive/negative sign opposite to that expected. Far from being a weakness in the methodology, this actually leads us to pay greater attention to this aspect than in other methods of balancing based on the smoothing of data (e.g. rAs, Cross Entropy…)[3].

Multiregional trade flow estimate

We refer to other publications for a more detailed description of the initial estimates used in the model[4], focusing our attention here on an important component of the multiregional table: the multiregional trade matrix T.

Evaluation of the trade flows of goods and services between couples of regions is one of the most delicate aspects in the construction of I-O regional tables, since it is through these bilateral trade flows that the most appropriate T matrix for the multiregional transactions per product can be derived. Despite the importance of this phenomenon, the information sources available in Italy are relatively scarce[5]. Particularly relevant for the purposes of our analysis are:

- the sample survey "Commodities Transport by Road", annually conducted by Istat, which records the flows of quantities of goods expressed in tons transported by road from one region to another, broken down into commodity macro-sectors[6];
- the sample surveys of the Banca d'Italia on industrial and service firms, which for 2009 recorded the nominal turnover "exported" from the region where the firm is located to the geographical macro area of destination (based on the NUTS 1 classification).

The advantage of the Istat data is that they detail trade from region to region, rather than from region to geographical area like those of the Banca d'Italia. On the other hand, the latter survey features characteristics which

[3] To quote Round (2003) again, "…it is a far better strategy to concentrate on improving the initial estimates and to use the smoothing techniques only in extremis or as a final resort."

[4] See, for example, Casini Benvenuti (2000).

[5] Some research institutes produce estimates of interregional trade, that is trade between one region and all the others, in terms of both export and import. Recently Prometeia has produced estimates of the balances of interregional trade for the period 1995-2005 (Francescon and Guagnini, 2010); however, these flows are not suitable for the analysis of sectoral interdependence, since they do not take into consideration all the potential bilateral flows between regions (multiregional trade).

[6] The commodities are codified using the 24-group NST/R classification, used at international level for statistics on commodity transport; at regional level the data are aggregated in 5 macro-sectors. Starting from the records relating to the year 2006 Istat has progressed to a pattern of measurement based on vehicle journeys, from which the commodity itineraries are obtained as derivatives; while on the one hand this method ensures a higher degree of accuracy regarding information on the kilometres travelled by the commodities, on the other it also entails a discontinuity in relation to the statistics referring to previous years. The last data published refer to the years 2006 and 2007. For further information, see the Istat note available at: http://www.istat.it/salastampa/comunicati/non_calendario/20100402_00/noteinfo.pdf. We should like to thank Donatella Berna of Istat for her valuable cooperation.

make it preferable to that of Istat for the purpose of constructing a matrix of trade between geographical areas; in fact, the Banca d'Italia survey:

1. also includes trade flows related to the services sector, which clearly could not be comprised in the commodities transport survey;
2. adopts a classification of the economic activities (Ateco) that is consistent with that used to identify the economic sectors in the national and regional accounts, unlike the classification adopted for commodities transport (NST/R);
3. indicates a magnitude (turnover in thousands of euro at current prices) that is not influenced by the mix of products included in each group, unlike that recorded by Istat (tons of goods transported).

Since the interest of the analysis resides in the interdependencies between macro areas, consistent with the dimensions of the Istat regional and national accounts, we decided to use the data from the Banca d'Italia surveys to identify the initial estimates of the matrix of trade flows between areas.[7] This is a unique and exclusive database, which for 2009 for the first time collected, *inter alia*, information on the turnover of 1,706 industrial firms and 697 service firms with 50 or more workers; the majority of these firms (1,338 and 624 respectively) also provided details of the breakdown of turnover between the four geographical macro areas, which were then used for the estimates[8].

For the estimate of the trade flows between geographical macro areas, countries or regions, the class of gravity models is frequently used, although

[7] There proved to be quite a high correlation of the trade flows between geographical areas emerging from the two surveys. To carry out this analysis it was first necessary to reconcile the Ateco 2002 and NST/R classifications. This reconciliation was possible only for the manufacturing sector, at a very aggregate level and introducing a number of approximations. The macro-sectors prevalently common to the two classifications are the following:

- Food products, beverages and tobacco products (Ateco 2002 subsection: DA);
- Textiles, apparel, leather and footwear, wood, manufacture of paper pulp and "other manufacturing industries" (subsections: DB, DC, DD, DE, DN);
- Coke, refined petroleum products, nuclear fuels (subsection: DF);
- Chemical, rubber and plastic products (subsections: DG, DH);
- Non-metallic mineral products (subsection: DI);
- Metallurgy and metal products (subsection: DJ);
- Extended mechanics (subsections: DK, DM, DN).

The correlation coefficient between the quantities of the goods transported between macro areas (expressed in tons) and the value of turnover sold to the macro areas (in thousands of current euro) were comprised between 0.73 and 0.90 for all the macro-sectors, with the sole exception of that of refined petroleum products (–0,09); this result is justified by the fact that the transport of this type of product takes place by road only to a minimal degree, with other means of transport (oil pipelines, ships) being much more typically utilised.

[8] For further information on the distribution of the firms recorded, the sampling method used and the quality controls adopted for the data, see the Supplements to the Statistical Bullettin – Sample Surveys, no. 38 (28 July 2010), available on: http://www.bancaditalia.it/statistiche/indcamp/indimpser/boll_stat/sb38_10/en_suppl_38_10.pdf.

they have been subject to limitations and critics[9]. In the case under consideration the gravity masses are represented by the output of one macro area and the demand of another, while the distance between the same is approximated by a decay, or deterrence, function. The gravity model is defined as:

$$_{rs}t_j=(_{r\bullet}t_j\bullet_{\bullet s}t_j)/t_j\bullet_{rs}\delta_j \qquad [4]$$

where $_{rs}t_j$ is the flow of sector j products that go from the macro area of origin r to that of destination s, $_{r\bullet}t_j$ is the total sector j production (net of foreign exports) in the macro area of origin r, $_{\bullet s}t_j$ is the total internal demand (net of imports from abroad) for sector j of the destination macro area s, t_j is a scale factor (total production net of sector j foreign exports) and $_{rs}\delta_j$ is an appropriate deterrence function.

The specification of the deterrence function proves to be crucial to the estimate of the gravity model. In the case of trade flows this function represents the "transaction costs" between the two macro areas in a broad sense, without which the origin and destination flows would be independent: in conditions of equilibrium, the net overall production of a certain area and of a certain sector would thus be divided between the areas in proportion to the net overall demand of each of them. With a view to isolating the effect of the "transaction costs" thus defined we can use the variable:

$$_{rs}\delta'_j={}_{rs}m_j/(_{r\bullet}m_j\bullet_{\bullet s}m_j/m_j) \qquad [5]$$

where $_{rs}m_j$ is the value of the goods/services belonging to sector j sold by the macro area of origin r to that of destination s as emerging from the sample surveys of the Banca d'Italia, while the product of the marginal distributions ($_{r\bullet}m_j\bullet_{\bullet s}m_j/m_j$) represents the value of the theoretical flow of goods/services that there would be without the "transaction costs" between the two macro areas. By definition, the variable $_{rs}\delta'_j$ illustrates the impact of such costs on bilateral commercial trade: if it is less than 1 the "transaction costs" depress the volume of trade; if it is greater than 1 these "costs" are fairly low and the trade thus proves to be particularly intensive. The variable $_{rs}\delta'_j$ can therefore be used as a dependent one in a model that includes among the regressors all the factors that influence the "transaction costs" and, through these, the trade flows between geographical areas.

Principal among these factors is distance, which is generally proportionate to the expense of trading the commodities. Distance, in turn, is greater or lesser depending on the extension of the network of links and the provision of infrastructures within the territory; for this reason, reference is made to the journey times of road transport, and in particular those of lorries, rather than to distances in kilometres[10].

[9] For a review of the literature, see for example Paarve (2008); about criticism of the use of these models see Baldwin and Taglioni (2006), Egger (2000) and Porojan (2001).

[10] The consideration of the journey time of the lorries rather than that of the kilometres travelled provides more precise indications about the effective distance between two areas, in

The importance of the two areas, in economic terms, ought to influence the reciprocal trade. We would expect that the greater the economic weight of the area, the more significant the flows of products and services sold elsewhere will be; moreover the economic development within the area could render the demand for goods and services originating from other areas less significant. For the purposes of this analysis the economic impact of an area is considered approximate to the per capita GDP.

Another variable to be borne in mind in the analysis of the trade of goods and services between geographical areas is the presence, in one of them, of manufacturing facilities belonging to a firm that has its administrative headquarters (HQs) in the other one. In this case, part of the flow of goods between the two areas is not determined by demand and supply but rather by the intra-industrial trade, so that it does not precisely reflect the sectoral interdependencies between the areas (Hewings and Munroe, 1999). In order to take this phenomenon into consideration, we recurred again to the surveys of the Banca d'Italia, which for some years now have recorded the distribution by geographical macro area of the employees of all the firms in the sample with at least 50 workers. The assumption is that, the greater the number of workers of a firm with administrative HQs in one area that work in another one, the more intensive and frequent the trade of products not connected with the local demand between the two areas.

The nature of the products traded also determines greater or lesser "transaction costs": for example, transporting slabs of marble costs more than transporting toys. Here we are talking about the so-called "tradability effect" (Casini Benvenuti and Paniccià, 2003), and in order to take this into account it is important to have at disposal sector data that are as disaggregated as possible. In the analysis we have made reference in particular to the subsections of the Ateco 2002 classification (cf. Appendix 3). The "tradability effect" is, moreover, connected with that of geographical distance: larger distances between areas expand the impact of the cost of transport of the commodities.

The regression model used, which sets the "transaction costs" between two macro areas (approximated by the variable ${}_{rs}\delta'_j$ defined above) in relation to the principal factors influencing trade between them, is of a multiplicative type[11]. In log-log form, this can be expressed as:

$$log({}_{rs}\delta'_j)=a+b\bullet log({}_{rs}DIST)+c\bullet log({}_rGDPP/{}_sGDPP)+d\bullet log({}_{rs}NADD_j)+e\bullet log({}_{rs}SETDIST_j)+\varepsilon \quad [6]$$

that it implicitly takes into account the "physical stock" of the available transportation infrastructures, the speed and the actual functioning of the connections (Messina, 2007). The journey times used refer to 2008; the data, available at provincial level, have been aggregated by region and/or macro area via simple averages.

[11] This implies that the contribution of the original (not transformed) variables is of an exponential rather than linear kind.

where:

- $_{rs}$DIST is the reciprocal of the distance (or closeness) between the macro area of origin r and that of destination s, measured on the basis of the road journey time of the trade vehicles;
- $_{r}$GDPP and sGDPP are the average per capita GDPs (1995-2006) of the origin and destination macro areas. The ratio of the two GDPs provides a relative measurement of the economic importance of the two areas: if the ratio is greater than 1 the impact of macro area r is greater than that of macro area s, the opposite if the ratio is less than 1;
- $_{rs}$NADDj is, for every j sector, the average number of employees (1995-2006) belonging to industrial firms with administrative HQs in macro area r that are permanently employed in production units located in macro area s;
- $_{rs}$SETDISTj is an interaction variable between j sector economic activity (type of goods produced) and the distance between macro areas r and s, obtained as a product of the variable rsDIST and a sector dummy, which ought to (at least partially) take in the tradability effect.

The estimates were performed separately for the manufacturing[12] and the services[13] sectors, because the modes and the "transaction costs" associated with the trade of commodities can be very different from those of services.

Records in which r=s, namely relating to trade within the same region, have been eliminated from the database so that only interregional trade flows are considered. The estimates were performed using the Ordinary Least Squares (OLS) method and are robust for heteroscedasticity and for the clustering effect for pairs of macro areas.[14] The results of the estimates are illustrated in Table 1[15].

[12] More specifically, the Ateco 2002 subsections from DA to DN (manufacturing industry) have been considered in the analysis, for a total of 15 sectors of activity; the data relating to the mining (sections CA and CB) and energy sectors (section E), despite being recorded in the Banca d'Italia survey, were not included in the gravity model since they feature peculiar characteristics in terms of both localisation of the activity and modes of transport of the products (cf. also note 17 below).
[13] Sectors G, H, I, K are recorded in the Banca d'Italia survey (non-financial private services); in the analysis, real estate and rental activities were excluded from sector K in view of the intrinsic characteristics that render them inappropriate for transfer between geographical areas.
[14] STATA® robust and cluster options.
[15] OLS estimates were also carried out on models different from those selected, with a view to testing their "robustness". For example, excluding from manufacture the sector DF (coke, refined petroleum products, nuclear fuels) which could have different characteristics from the other sectors in terms of transport, and including the sector of real estate and rental activities in the services; or again by also inserting the simple sector dummies (that is not interacted with distance) or only the latter; finally, considering the manufacturing industry and the services sector together. The results of these control estimates – which the authors have at their disposal and can furnish to those who are interested – confirm the preferences for the chosen

Table 1 – Results of the estimates of the deterrence function
Dependent variable: actual/theoretical trade ratio ($_{rs}\delta'_j$)

Regressors (in log)	Manufacturing industry	Services Sector
Distance reciprocal ("closeness")	0.268437 *	0.600327 **
Per capita GDP ratio	-0.090194	0.415392 ***
Number of "intra - industry employees"	0.115050 ***	
Interaction dummies:		
dist.recip.*DB	-0.010306	
dist.recip.*DC	-0.176002	
dist.recip.*DD	-0.133252	
dist.recip.*DE	0.043095	
dist.recip.*DF	0.578275	
dist.recip.*DG	0.193916 *	
dist.recip.*DH	-0.127741	
dist.recip.*DI	0.094702 *	
dist.recip.*DJ	0.034911	
dist.recip.*DK	0.051716	
dist.recip.*DL	0.182701 **	
dist.recip.*DM	0.094904	
dist.recip.*DN	-0.096694	
dist.recip.*H		-0.041849
dist.recip.*I		-0.175760
dist.recip.*K(1)		-0.222338
Constant	-0.254120	-0.350288
N	157	48
R^2	0.294	0.281

Legend: * prob. < 0.050; ** prob. < 0.010; *** prob. < 0.001
Source: Authors calculations on Banca d'Italia and Istat data.

From examination of the table we can note that for both manufacturing and services the closeness between two areas has a significant effect on trade, and with the expected sign: the closer the areas the more intensive the trade. The interaction dummies between the reciprocal of the distance and the type of product prove mostly to be insignificant, with the exception of the sectors of chemical (sector DG), non-metal mineral products (DI) and electrical appliances (DL), for which the overall effect of the closeness between the areas proves to be even stronger[16].

For manufacturing, as expected, a major stimulus to the increase in trade flows is generated by intra-industrial connections between the two are-

models. Improvements in the estimates could be made by having available more than one sample record on the turnover for exports to other areas and/or by having greater geographical details about the flows (e.g. at regional level rather than for macro areas).

[16] Significance tests on the sum of the coefficients of the interaction dummies and that of the distance reciprocal indicate that for several sectors (e.g. non-metal minerals, chemical products, mechanical and electrical devices) the distance is decisive for the intensity of trade flow between the areas; for other sectors (e.g. fashion system, wood, rubber and plastic, not otherwise classified manufacturing products) this factor is less important.

as under consideration: the stronger these links, the greater the flows of traded products. On the other hand, we have the apparently surprising fact that the relative dimensions of the two economies (the ratio of the per capita GDPs of the areas) do not have significant effects on trade. This could depend on the fact that part of the effect of the economic impact of the area relies, for manufacture, on the intra-industrial relations, which effect is estimated separately.

In the services sector instead – in the absence of information about the links between firms belonging to different macro areas – the effect of the relative economic weight is significant: the greater the size (in economic terms) of the area in which the services are generated in comparison to that of destination, the greater the flow of non-financial private services to the latter area. On the other hand, the tradability effect is not significant: the different nature of the services (hotels and restaurant, transport, commerce etc.), associated with the distance between the areas, does not influence the volume of the trade flows.

In general we should note that, in comparison to estimates made in other studies, the availability of information on the destination of the turnover and the breakdown of employees by geographical area appears to weaken the distance effect which, although it still remains the most important factor, nevertheless reveals a more modest impact[17].

Moving on to the original multiplication model, we obtain the predicted values of the deterrence function:

$$ {}_{rs}\delta_j^* = a \cdot ({}_{rs}DIST)^{b} \cdot ({}_{r}GDPP/{}_{s}GDPP)^{c} \cdot ({}_{rs}NADD_j)^{d} \cdot ({}_{rs}SETDIST_j)^{e} \quad \textit{(manufacture)} \quad [7.i] $$

$$ {}_{rs}\delta_j^* = a' \cdot ({}_{rs}DIST)^{b'} \cdot ({}_{r}GDPP/{}_{s}GDPP)^{c'} \cdot ({}_{rs}SETDIST_j)^{e'} \; \textit{(non-financial private services)} \quad [7.ii] $$

The ${}_{rs}\delta_j^*$ values thus estimated can be substituted for the ${}_{rs}\delta_j$ in the gravity equation [4], so as to derive the ${}_{rs}t_j^*$ estimates, elements of the initial estimate $\mathbf{T}(0)$ of the matrix of the trade transactions by sector[18] between macro areas[19].

[17] In the estimates for Italy recorded in Ghezzi *et al.* (2009) on data at regional level and with a definition of distance based on kilometres, the distance reciprocal coefficient (in log) proves for example to be 0.87. Studies carried out on the trade flows between the U.S.A. and Canada yield similar values (0.82, cf. Anderson and van Wincoop, 2003) or greater than 1 (Wall, 2000).

[18] The same coefficients estimated for manufacture were applied to the mining sector. For the initial estimates of trade in the energy sector the Terna data were used (www.terna.it/default/Home/SISTEMA_ELETTRICO/statistiche.aspx). As regards the flows of financial services between areas, the regional data relating to the entity of cash loans reported to the Central Credit Register were used (source: Banca d'Italia) with reference to 31/12/2006, which make it possible to identify the loans made at bank branches located in one area to borrowers resident in another. For the remaining services (public sector, education, health etc.) reference has been made to the Istat Regional Economic Accounts (REAs).

[19] The balancing process described in Appendices 1 and 2 also takes in the variance of the econometric estimate.

The structural model and its reduced form

Once estimated the MRSUT for the 20 Italian regions (NUTS 2) it is possible to proceed toward a four macro areas aggregation (NUTS 1). Starting from this table the next step has been the transformation of the MRSUT in a symmetric MRIO table industry by industry according the industry technology hypotesis[20].

The MRIO model related to the above table is based on two main causal relations:

- a leontevian technical relation, which determines the regional demand of intermediaries product and then, with the exogenous final demand, the total demand of each macro region;
- an allocative relation (multiregional trade pattern), which determines the macro regional output by distributing across the regions the total interregional demand.

In a system without foreign trade it is possible to formalize the above relations in the following way:

$$d = A \cdot x + df \qquad [8.i]$$

$$x = T \cdot d \qquad [8.ii]$$

where d is the total demand of the system (final and intermediate). In the [8.i] the relation between the activation of the productive process and the demand of intermediate goods and services is quantified by the technical coefficient matrix A. In the [8.*ii*] the allocation pattern is represented by the matrix of the multiregional trade coefficients T. The model assumes competitive interregional import with regional output and foreign import[21].

Hereafter the structural form:

$$x + sx + mw + mr \equiv di + df + ew + er \qquad [9.i]$$

$$di = A \cdot x \qquad [9.ii]$$

$$df_{pa} \equiv c + ifl + g + div \qquad [9.iii]$$

$$df = df_{pa} \cdot (I - S_d) \cdot L_{df} \qquad [9.iv]$$

$$ew = ew_{pa} \cdot (I\text{-}S_{ew}) \cdot L_{ew} \qquad [9.v]$$

$$s_x = S_x \cdot A \cdot x \qquad [9.vi]$$

$$mw = \mathrm{M} \cdot (A \cdot x + df) \qquad [9.vii]$$

[20] We intentionally skipped the debate on the technology representation (industry-product), which is not the focus of our paper.

[21] This is a typical Chenery (1953)-Moses (1955) class of models, in between the pool approach (Leontief *et al.* 1977) and the pure interregional model (Isard 1960).

$$mr = \overset{\frown}{B} \cdot (I - \hat{M}) \cdot [(A \cdot x + df)] \qquad [9.viii]$$

$$er = \breve{B} \cdot (I - \hat{M}) \cdot [(A \cdot x + df)] \qquad [9.ix]$$

where: x = output at basic prices; di = intermediate demand at basic prices; s_x = net taxes on intermediary products; mw = foreign import (fob); mr = interregional import; df = domestic final demand at basic prices; df_{pa} = domestic final demand at purchasing prices; ew = foreign export (fob) at basic prices; ew_{pa} = foreign export (fob) at purchasing prices; er = interregional export; c = household expenditure; g = government and NPISHs expenditure; ifl = gross fixed investment; div = changes in inventories; A = intermediate input coefficients; L_{df}, L_{ew} = matrices of allocation of trade and transport margins; S_x = net product taxes on intermediary products coefficients; S_d = net product taxes on domestic final demand coefficients; S_{ew} = net product taxes on foreign export coefficients; M = foreign import coefficients; $\overset{\frown}{B}, \breve{B}$ = Interregional import-export coefficients from the transformation of the multi-regional trade flows coefficients matrix T. In particular:

$$T = I - \hat{B} + \breve{B} \qquad [10]$$

In equation [11] the reduced form of the model [9]:

$$x = \underbrace{\left[(I + S_x) - \underbrace{T \cdot \left(I - \hat{M}\right)}_{R} \cdot A \right]^{-1}}_{INV} \cdot \left[\underbrace{T \cdot \left(I - \hat{M}\right)}_{R} \cdot \underbrace{df_{pa} \cdot (I - S_d) \cdot L_{df}}_{df} + \underbrace{ew_{pa} \cdot (I - S_{ew}) \cdot L_{ew}}_{ew} \right] \qquad [11]$$

which could written as:

$$x = INV \cdot (R \cdot df + ew) \qquad [12]$$

The equation [12] constitutes the starting point for the computation of the multipliers of domestic final demand, final production and value added at purchasing prices which will be utilised later on the paper and analyzed more in detail in Appendix 4.

Analysis of the structural characteristics of the production system

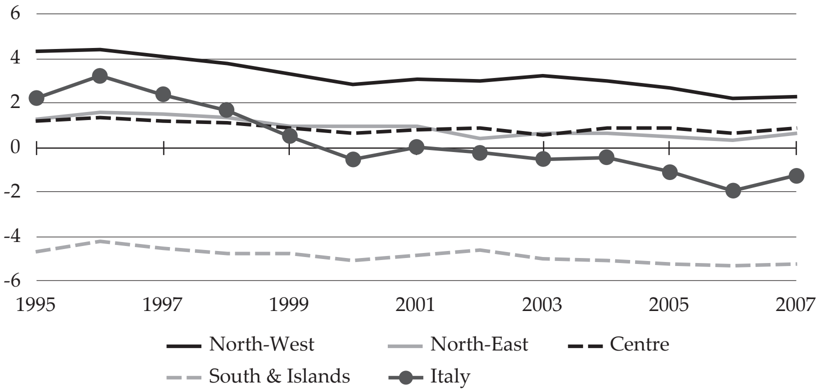
A classic utilisation of the MRIO model consists of the analysis of the interdependencies between the different areas. These relations represent the essence of any multiregional pattern since they contribute to determining the capacity of each macro area to "internalise" the multiplier effects of the domestic final demand (which remains partly exogenous in the model) and of the external final demand. Consequently through the multiregional model we can evaluate the exposure of the economy to national and international cycle: two different but significant aspects for the growth of each region (Costa and Martellato, 1990).

The analysis of the characteristics of the Italian production system through the interdependencies between the four geographic macro areas (NUTS 1) will be developed through two different approaches: the first, more aggregate, will concentrate on the analysis of the trade balances; the second will be based on the analysis spatial linkages.

The trade balances

To focus some of the structural characteristics of the different areas of the country, we can start by taking a look at the trade balances. Figure 1 shows the data available in the Istat Regional Economic Accounts (REAs) for the period 1995-2007[22].

Figure 1 – Ratio of net total exports to national GDP, 1995-2007



Source: Authors calculations on Istat data.

The data demonstrate, firstly, the deterioration of the national foreign trade balance, which has become permanently negative since 2002. From examination of the overall balances (interregional and foreign) of the single macro areas, it emerges that the South is the only area characterised by a trade deficit, falling slightly in the period under consideration (from -4.6 per cent of the national GDP in 1995 to -5.2 in 2007). The trade surpluses of the Centre and North-East remain stationary at around 1 per cent of the national GDP; in the North-West it drops considerably, nonetheless remaining at levels higher than 2 per cent of the national GDP.

[22] The values of the net national exports differ from those published by Istat since, consistently with the REAs – and unlike the national accounts published by the same Institute – the expenditure of non-residents within the macro region and of residents abroad and/or in other macro regions have been excluded from the interregional and foreign imports and exports. The REAs data refer to the Istat publication of November 2009.

The multiregional tables referring to 1995, 2001 and 2006 make it possible to break down the above balances also by geographical macro area of origin/destination. Table 2, read by column, summarises this information, proposing the net balances as percentage of the GDP of the macro region of destination. For example, in 2006 the North-West recorded positive net exports in relation to the North-East amounting to 2.6 per cent of its GDP, while for the North-East this balance obviously recorded an opposite sign, representing 3.6 per cent of the GDP of the macro region.

Table 2 – Net interregional and foreign exports as percentages of the GDP of the destination macro area

		Area of destination								
	Area of origin	North-West		North-East		Centre		South & Islands		ITALY
1995	North-West			-4.3	(-4.3)	0.4	(-1.7)	-4.8	(-4.9)	
	North-East	2.9	(3.0)			0.5	(-0.5)	-2.8	(-2.8)	
	Centre	-0.3	(1.1)	-0.5	(0.5)			-4.7	(-4.6)	
	South & Islands	3.5	(3.6)	3.0	(3.0)	5.4	(5.3)			
	Total Areas	6.1	(7.7)	-1.8	(-0.8)	6.3	(3.1)	-12.3	(-12.3)	
	Rest of the World	7.2		7.6		-0.6		-7.0		2.2
2001	North-West			-3.7	(-3.8)	0.4	(-1.3)	-4.1	(-4.2)	
	North-East	2.6	(2.6)			0.7	(-0.3)	-2.9	(-3.0)	
	Centre	-0.3	(0.8)	-0.6	(0.2)			-4.1	(-4.0)	
	South & Islands	3.1	(3.2)	3.2	(3.2)	4.7	(4.6)			
	Total Areas	5.4	(6.6)	-1.1	(-0.4)	5.8	(3.0)	-11.1	(-11.2)	
	Rest of the World	4.2		5.4		-1.9		-8.8		0.0
2006	North-West			-3.6	(-3.5)	0.7	(-1.1)	-3.5	(-3.4)	
	North-East	2.6	(2.5)			0.9	(-0.4)	-2.3	(-2.3)	
	Centre	-0.5	(0.8)	-0.9	(0.4)			-4.5	(-3.5)	
	South & Islands	2.6	(2.5)	2.5	(2.4)	5.0	(3.9)			
	Total Areas	4.7	(5.8)	-2.0	(-0.7)	6.6	(2.4)	-10.3	(-9.2)	
	Rest of the World	2.4		3.7		-3.5		-11.6		-1.9

Note: in brackets the net balances of interregional flows excluding collective consumption services (CCS).
Source: *A*uthors calculation on Istat and MRIO-IRPET data.

Examination of Table 2 confirms the deterioration in the balance of the net national exports, which dropped from 2.2 per cent in 1995 to –1.9 in 2006, as a result of a weakening of the balance of trade that affected all the macro regions. Among them, the North-East consolidates its position as the area with a relative foreign trade balance better than the other ones.

As regards interregional trade, the South confirms its negative balance position in relation to all the other macro regions. In the three years taken into consideration the balance has diminished by around two percentage points on the area GDP. The negative value of the net exports from the South illustrates a significant relationship of dependency between the South and the rest of the country which persists even in the 2000 years. It should also be noted that the net imports from abroad have undergone a marked increase in the same period.

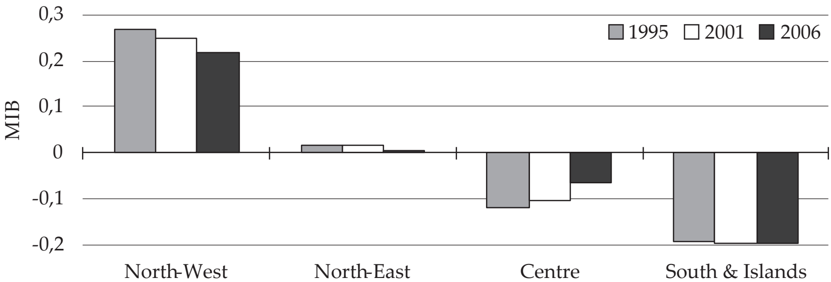
Netting the interregional flows of collective consumption services (CCS, cf. Appendix 5) we obtain the values shown in brackets in Table 2. In this case too, the North-Western regions confirm a markedly greater activity than the other macro areas. In the three years examined there is a very slight attenuation of the negative balance of the North-East towards the North-West and of its positive balance towards the South. The latter area continues to be distinctly dependent on the others, even considering trade net of the CCS flows, although the attenuation of the phenomenon over time proves to be deeper (around 3 percentage points).

The macro area of the Centre needs to be dealt with separately, due to the presence of the Lazio region which is characterised by a major interregional surplus of CCS. If we eliminate these data from the multiregional flows, the balances change significantly: the trade balance of the Centre drops in relation to the rest of the country by about 4-5 percentage points of the GDP; the area becomes a net importer in relation to the Northern regions.

From the examination of the accounts we can then move on to an *ex ante* analysis of the trade balances between the macro areas using the marginal interregional trade balance (MITB) introduced by Costa and Martellato (1987). This index proves to be particularly useful for it makes it possible to estimate the triggering of interregional deficits/surpluses in the different economic systems in response to an impulse of the internal final demand of the area that simultaneously involves all the areas. This index takes on positive values in the case of an impact on interregional exports greater than that on imports, and negative in the opposite case[23].

Figure 2 shows the MITBs for the four macro areas for, net of the interregional CCS flows, in the three years examined.

Figure 2 – Marginal interregional trade balance (MITB) per macro area



Note: balances net of interregional flows of collective consumption services(CCS).
Source: Authors calculations on Istat and MRIO-IRPET data.

[23] The MITB of the r-th region is defined by the following ratio: $MITB_r = \frac{\left(\sum_k \alpha_{rk} - \sum_k \alpha_{kr}\right)}{\alpha_{rr}}$ per k≠r, where: a_{kr} = multiplier of the imports from k to r; a_{rk} = multiplier of the exports from r to k; a_{rr} = multiplier of internal production.

We can observe that a unitary increase in the internal final demand of each macro area triggered in the South a multiplier effect on exports to the other macro areas lower than the multiplier effect of the imports from the same macro areas, determining a negative MITB (amounting to around -0.19) in all three years considered; the trigger is negative in the Central regions too, albeit in progressive improvement (from -0.12 in 1995 to -0.06 in 2006). On the contrary, the same impulse triggered in the North-West a multiplier effect of interregional exports greater than that of the imports from the other macro regions, generating a MITB that was positive, albeit progressively weaker (from 0.27 in 1995 to 0.22 in 2006). Finally, the North-East registered a MITB almost null, indicating the substantial equivalence between the multiplier effects of exports and imports between the macro areas in response to a common stimulus of the internal final demand.

As already mentioned (cf. note 22) the uses and resources accounts of the individual regions are published by Istat in a different format from that of the corresponding national accounts. While in the regional economic accounts only the domestic final expenditure of households is recorded, in the national accounts the national final expenditure is entered. This results in an allocation of the expenditure flows of residents abroad to import of services, while consumption includes only the expenditure of residents in the national territory. The balancing with the GDP is obtained by allocating the expenditure of the non-residents within the national territory to export of services. Using the IRPET estimates of the interregional expenditure flows of resident families[24] and the Banca d'Italia data regarding the foreign expenditure of the non-residents[25] it is possible to modify the trade balances of Table 2 and render them consistent with those published by Istat for the national economic accounts (Table 3).

We can note that with the introduction of this new definition of the final expenditure of households we obtain, especially for the macro regions with a more marked tourist vocation, balances different from those recorded in Table 2 (repeated for convenience in brackets). We can also note an improvement in the foreign balances for all the macro regions, which is obviously reflected at national level (in 2006 the balance went from -1.9 to -0.8 per cent).

As regards interregional trade, in 2006 the balances of the South improved in relation to all the other macro regions; the new classification has a positive impact on the Centre and the North-East, while it results in a deterioration of the balances of the North-West in relation to the other areas.

[24] See Falocci, Paniccià and Stanghellini (2009).

[25] These data are collected through the Italian international tourism survey "Turismo internazionale dell'Italia" (http://www.bancaditalia.it/statistiche/rapp_estero/altre_stat/turismo-int, only available in Italian).

Table 3 – Net interregional and foreign exports (net of CCS flows) including the balances of expenditure of resident and non-resident families, as percentage of GDP of the destination macro area

		Area of destination									
	Area of origin	North-West		North-East		Centre		South & Islands		ITALY	
1995	North-West			-3.5	(-4.3)	-0.9	(-1.7)	-4.3	(-4.9)		
	North-East	2.4	(3.0)			-0.4	(-0.5)	-2.6	(-2.8)		
	Centre	0.6	(1.1)	0.4	(0.5)			-4.6	(-4.6)		
	South & Islands	3.2	(3.6)	2.8	(3.0)	5.2	(5.3)				
	Total Areas	6.2	(7.7)	-0.3	(-0.8)	3.9	(3.1)	-11.5	(-12.3)		
	Rest of the World	7.8	(7.2)	10.8	(7.6)	2.0	(-0.6)	-6.5	(-7.0)	3.8	(2.2)
2001	North-West			-3.2	(-3.8)	-1.0	(-1.3)	-3.8	(-4.2)		
	North-East	2.2	(2.6)			-0.2	(-0.3)	-2.8	(-3.0)		
	Centre	0.6	(0.8)	0.2	(0.2)			-3.9	(-4.0)		
	South & Islands	2.8	(3.2)	3.0	(3.2)	4.5	(4.6)				
	Total Areas	5.6	(6.6)	0.0	(-0.4)	3.3	(3.0)	-10.5	(-11.2)		
	Rest of the World	4.6	(4.2)	7.8	(5.4)	0.5	(-1.9)	-8.2	(-8.8)	1.4	(0.0)
2006	North-West			-2.9	(-3.5)	-0.8	(-1.1)	-2.8	(-3.4)		
	North-East	2.0	(2.5)			-0.5	(-0.4)	-2.0	(-2.3)		
	Centre	0.5	(0.8)	0.4	(0.4)			-3.3	(-3.5)		
	South & Islands	2.1	(2.5)	2.1	(2.4)	3.6	(3.9)				
	Total Areas	4.6	(5.8)	-0.4	(-0.7)	2.3	(2.4)	-8.1	(-9.2)		
	Rest of the World	2.8	(2.4)	5.4	(3.7)	-1.4	(-3.5)	-11.0	(-11.6)	-0.8	(-1.9)

Source: Authors calculations on Istat, UIC and MRIO-IRPET data.

Analysis of the structural features

The trade balances examined so far do not provide details on the direction and intensity of the activation processes generated by the domestic and external (interregional and foreign) final demand of the macro regions. These processes are fundamental for the understanding of the relations of interdependence among areas, and between these and abroad.

We therefore need to explore in depth the structural characteristics of a system, since these have an impact on the speed and intensity with which a shock generated in one area and one sector of the system spreads to the rest of the economy. Referring to the papers quoted at the beginning for a more detailed analysis of multipliers we will focus our attention on two structural analysis exercises.

The trade linkages

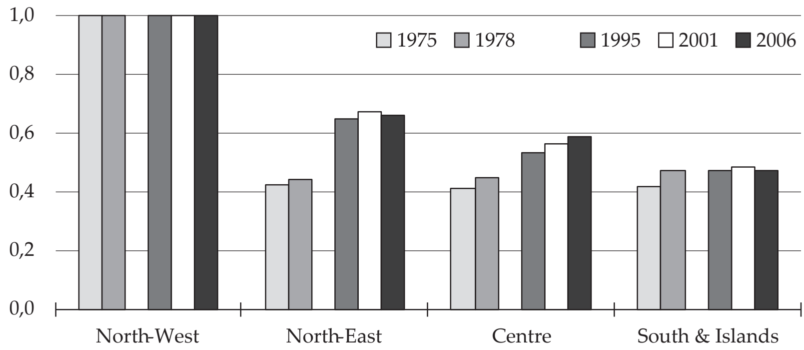
The typical multipliers are, as a consequence of the construction characteristics of the model [8.*i*-8.*ii*], conditioned in terms of both the trade pattern of the different inputs between the macro regions (through the transactions matrix T) and the set of production techniques locally used (through the technology matrix A). If we are interested in determining the productive capacity demanded of each macro region – in order to satisfy the share of domestic demand of the area itself and that originating from other areas – we have to take into consideration solely the pattern of the multiregional trade, net of the effects due to the regional differences in technology. This leads to a calculation of the production triggered solely by multiregional trade, that is by the trade "commanded" by the matrix *T*, neutralising the effects due to technology. The [8.*ii*] will therefore be transformed into:

$$x = Tx \qquad [8.ii^*]$$

The (non banal) solution of the homogenous system [8.ii*] is obtained by extracting the eigenvector associated with the unit eigenvalue of the matrix T. The elements of the eigenvector represent the ratios between the levels of production in the various macro regions (but not the levels themselves) admitted by the matrix *T* (Costa and Martellato, 1987 and 1990).

Figure 3 shows the relations between the levels of production triggered in the various macro areas for all the sectors, setting as 1 the production that is triggered solely by multiregional trade in the North-West (the area where the phenomenon is greater) for the three years taken into consideration in this study and for 1975 and 1978, derived from Costa and Martellato (1987)[26].

Figure 3 – Production triggered by interregional trade net of the effects attributable to technology (North-West=1)



Source: Costa and Martellato (1987) for the years 1975 and 1978, authors calculations on MRIO-IRPET data for the other years.

We can observe how the production "commanded" to the Southern regions solely by multiregional trade did not undergo any substantial variations between 1978 and 2006, remaining less than half that of the North-West. Instead, in the North-East and in the Centre the production

[26] On page 41 of the cited work we find the same indicators calculated for the four geographical areas with a model that is similar, in terms of spatial disaggregation and theoretical approach, to that used in this study: the INTEREG model. The results of Costa and Martellato (1987) for the years 1975 and 1978 can therefore be compared – for the set of all sectors – with those of the years 1995, 2001 and 2006.

triggered by the pure trade flows has increased in recent years to arrive, in relation to that of the North-West, at around 65 per cent in the North-East and little below 60 per cent in the Centre; since in 1978 the relations between the levels of production were, for both areas, below those of the South, it demonstrates that these two macro regions have increasingly integrated their production with that of the North-West[27].

Interregional backward and forward linkages: a taxonomy

An important structural analysis is based on the classification of the industries according to the extension and intensity of their backward and forward linkages[28]. The ultimate aim of this analysis is to identify the key (nodal) sectors (à la Hirshman) or, more in general, a taxonomy of industries. In this exercise the object of analysis will be the interregional/foreign intermediate and final linkages of the Italian regions (instead of sectors).

In this paper we will utilize the approach proposed by Dietzenbacher (1992), which allows weighting the different sectors proportionally to their size of linkages. Differently from the Chenery-Watanabe and the Rasmussen approaches, Dietzenbacher weights the elements of matrix A (technical coefficients) and B (Goshian coefficients)[29] proportionally to their back/forward linkages size. The problem is how to estimate these weights. By weighting numerator and denominator of the Chenery-Watanabe formulas we can express the backward linkages as:

$$L_B = n \cdot \frac{q'A}{q'Ai} \qquad [13.1]$$

and the forward linkages as:

$$L_F = n \cdot \frac{Bz}{z'Bi} \qquad [13.2]$$

where: n = number of sectors/regions; z, q = column vectors of weights proportional to linkages. Dietzenbacher has demonstrated that vectors z and q are the right and left eigenvectors associated to the dominant eigenvalue of B and A. Thus equation [13.1] can be written as:

[27] These features can be observed, for example, in relation to the South by using the data recorded in Ferrara (1976) regarding the percentage breakdown of the resources of the area on the basis of their origin and their destination, available with reference to the year 1969. In the 37 years separating the two analyses, as against a drop of around 10 percentage points of the impact of both internal demand and production, that of net foreign imports has gone up (from 3 to 5 percentage points), while that of net interregional imports has remained practically unchanged (about 3/4 percentage points).

[28] The most important contributions are those of Rasmussen (1956) and Chenery and Watanabe (1958). For an exhaustive review see Miller and Blair (2009).

[29] The use of the Goshian coefficients in quantifying the forward linkages follows Beyers (1976) and Jones (1976).

$$L_B = \frac{nq'}{q'i} \qquad [14.1]$$

where q is the eigenvector associated to the dominant eigenvalue of $q'A = \lambda q'$. Similarly, equation [13.2] can be written as:

$$L_F = \frac{nz}{iz'} \qquad [14.2]$$

where z is the eigenvector associated to the dominant eigenvalue of $Bz = \lambda z$.

In taxonomic terms a value of L_B and L_F greater than unity identifies a region with significant forward/backward linkages. In a system closed to external trade this allows to define a double entry classification by combining the occurrences according to the values of vectors L_B and L_F: 1 if they are greater than 1, 0 in the opposite case; the regions or sectors can thus be assigned to four different categories, as shown in Table 4.

Table 4 – Classification of sectors/regions by type of linkages in a closed economy

		Output destination *(forward)*	
		Intermediate	Final
Output formation *(backward)*	Intermediate	(I) L_F>1 and L_B>1	(III) L_F<1 and L_B>1
	Primary	(II) LF >1 and LB <1	(IV) LF <1 and LB <1

According to the quadrant where regions/sectors are assigned, we can distinguish:

I. Intermediate-Intermediate regions/sectors, with high requirement of intermediate products and services. They prevalently sell intermediate products and services to other regions/sectors, showing strong backward and forward linkages. Therefore they can be considered the nodal regions/sectors;

II. Primary-intermediate regions/sectors, with high requirement of primary inputs (value added). They sell intermediate products and services;

III. Intermediate-final regions/sectors, which buy intermediate products and sell to final demand;

IV. Primary-final regions/sectors, which demand and sell a low amount of intermediate products and thus have low linkages with other regions/sectors.

In order to analyse the linkages at a spatial level (instead of sectoral level) we have to go back to the MRIO model for 20 regions (NUTS 2) and utilize the following matrices and vectors derived from the MRIO table:

- matrix TX describing the total intermediate flows amongst region. Its generic element is tx_{ij} = total intermediate flows from region i to region j;
- matrix TF representing the total regional final demand flows within the region, exports to the other regions (interregional exports) and foreign exports. Its generic element is, for example, $tf_{i(ew)}$ = total regional final demand of region i to foreign exports;
- vector tw of total intermediate foreign imports by the regions;
- vector of regional value added ty.

The total regional output will then be:

$$x = iTx + tw + ty \qquad [15]$$

From these matrices it is possible to estimate the coefficients needed for the analysis:

$$R = TX \cdot \hat{x}^{-1} \qquad [16]$$

that is the amount of intermediate input required by region i from region j needed to produce one unit of output in region j.

If we add the foreign import of intermediate products to the diagonal of TX we obtain the matrix of total intermediate input, in particular for region i we could compute the matrix A as:

$$A = (TX + tw) \cdot \hat{x}^{-1} \qquad [17]$$

which will be similar to R except for the diagonal which represents the total amount of intermediate input required by the region j.

In our analysis we will also utilize the Goshian coefficient matrix B computed as follows:

$$B = \hat{h}^{-1} \cdot TX \qquad [18]$$

where:

$$h = TXi + TFi \qquad [18.1]$$

The Dietzenbacher (1992) sectoral approach needs some integrations when utilized in a multiregional system because it should necessarily take into account that:

a) intermediate input could be imported from abroad;
b) final demand should be separated by destination, that is national (local and interregional) and foreign.

The "spatial linkages" have been calculated in three steps. First, L_B and L_F have been computed through matrices A and B (see eqs [17] and [18]). Second, regions with L_B>1 have been further divided into regions with prevalence of intermediate inputs imported from abroad and the others, according to the matrix R (see eq [16]); this leads to computing the following backward spatial linkages:

$$ {}_{R}L_{B} = n \cdot \frac{z'R}{z'Ri} \qquad [19] $$

As in the case of total linkages, ${}_{R}L_{B}$<1 identifies prevalence of intermediate input coming from abroad. Third, regions with main destination of output towards final demand have been identified through $L_F > 1$, and they have been split into regions which are mostly foreign exporters and the others; in order to do it, computing for each region the allocation shares *f* of the final demand (matrix *TF*) we can calculate the following forward spatial linkage:

$$ LF_{EX} = n \cdot \frac{fi}{i'fi} \qquad [20] $$

where *f* = vector of share of exported final demand. If LF_{EX} is greater than 1, a region allocates a significant part of final demand for foreign export.

The integration of the Dietzenbacher (1992) approach with these "spatial linkages" leads to an additional breakdown of the classification of the regions. In fact instead of four quadrants (see Table 4) we have now nine cells in the double entry Table 5.

Table 5 – Classification by type of linkages (in an open economy)

Output formation *(backward)*		Output destination *(forward)*: Intermediate	Final: National (local and interregional)	Final: Foreign Export
Intermediate	National	*(Ia)* (L_F>1 and L_B>1) and (${}_{R}L_{B}$>1)	*(IIIa)* (L_F<1 and L_B>1) and (${}_{R}L_{B}$>1) and (LF_{EX}<1)	*(IIIc)* (L_F<1 and L_B>1) and (${}_{R}L_{B}$>1) and (LF_{EX}>1)
Intermediate	Imported from abroad	*(Ib)* (L_F>1 and L_B>1) and (${}_{R}L_{B}$<1)	*(IIIb)* (L_F<1 and L_B>1) and (${}_{R}L_{B}$<1) and (LF_{EX}<1)	*(IIId)* (L_F<1 and L_B>1) and (${}_{R}L_{B}$<1) and (LF_{EX}>1)
Primary		*(II)* [(L_F>1) and (L_B<1)]	*(IVa)* [(L_F<1) and (L_B<1)] and (LF_{EX}<1)	*(IVb)* [(L_F<1) and (L_B<1)] and (LF_{EX}>1)

According to this new taxonomy regions are grouped as follows:

I. Intermediate-intermediate: in a open economy only a part of these regions (the ones in quadrant Ia) could considered "nodal" because their intermediate demand triggers more regional intermediate production than foreign intermediate imports; the other ones (regions in quadrant Ib), in fact, mainly activate intermediate imports from abroad;

II. Primary-intermediate: as in Table 4;

III. Intermediate-final: these regions can be further classified into four groups according to the following features:

IIIa. strong backward linkages with other regions and prevalence of local/interregional final demand;

IIIb. strong backward linkages prevalently fulfilled with foreign imports and local/interregional destination of final demand: these regions have therefore a negative significant impact on foreign trade balance;

IIIc. strong backward linkages with other regions and prevalence of foreign export: though not "nodal", these regions have a positive significant impact on foreign trade balance because their regional intermediate production is mainly triggered by final demand from abroad;

IIId. strong backward linkages prevalently fulfilled with foreign import and partly balanced by output destination to foreign export;

IV. Primary-final: regions with low backward linkages and output destination mainly towards final local demand (IVa) or foreign demand (IVb).

Applying this new classification to the Italian case produces, for the year 2006, the taxonomy shown in Table 6. The main results are the following:

- Only three regions, all belonging to the North-West, are classified in quadrant (Ia) and can therefore be considered "nodal" (Piedmont, Lombardy and Emilia Romagna);
- Four more regions, two from the North-East (Veneto, Friuli-Venezia Giulia) and two from the Centre (Tuscany, Marches), are classified in quadrant (IIIc) and – as intermediate-exporters – have a positive effect on the national trade balance;
- There are no regions in quadrant (IIIb) as most of them show a significant share of value added in their output formation;
- As expected, almost all Southern regions are classified in quadrant (IVa), with low forward intermediate linkages with other regions, high value added requirement and national destination of output;
- The capital region Lazio is in quadrant (II), essentially due to the presence of public administration (intermediate) services.

Table 6 – Classification of the Italian regions by type of linkages

		Output destination (*forward*)		
		Intermediate	Final	
			National (local and interregional)	Foreign Export
Output formation (*backward*): Intermediate	National	Piedmont, Lombardy, Emilia-Romagna		Veneto, Tuscany, Marches, Friuli-Venezia Giulia
Output formation (*backward*): Intermediate	Imported from abroad	Sardinia		
Output formation (*backward*): Primary		Valle d'Aosta, Umbria, Lazio	Molise, Campania, Apulia, Calabria, Basilicata, Sicily	Trentino-Alto Adige, Liguria, Abruzzo

Conclusions

In this article we have presented a Multiregional Input-Output (MRIO) model that introduces significant improvements for the estimate of trade flows between the regions – a key element in all sub-national models – by exploiting information gathered through sample surveys of industrial firms and non-financial private service firms.

From an analytic point of view, the adopted model is typically demand-driven and makes it possible to assess the spatial distribution of the trigger, in terms of output and added value, deriving from changes in the final demand. The time-span investigated – the twelve years between 1995 and 2006 – is sufficiently broad to take in any changes in the structure of the spatial and sectoral interdependencies of the Italian economy.

The results obtained confirm, first and foremost, the position of negative trade balance of the South in relation to all the other macro regions, indicating a significant dependence of this area on the Centre-North. Added to this dependency is a level of net imports from abroad that has grown considerably over the twelve years considered. Therefore, an increase in the internal final demand triggers in the southern regions a multiplier effect that tends to deteriorate its interregional trade balance. The creation of spill over effects for the Centre-North proves to be even clearer if we consider only the manufacturing sector, the impact of which on the economic system of the South is lower than that of the other areas. Even allowing for the differences in the productive technology employed, the production globally "commanded" to the southern regions to meet the internal final demand for the area and that originating from the Centre-North is around half that of the most developed area of the country, the North-West.

In short, the study casts light on the fact that the demand for goods and services addressed to the South only partially produces effects on the local economy, while it triggers production in other geographical areas, in particular in the North-West. We therefore have confirmation of the persistence of a polarizing effect of the final demand trigger to the detriment of the South.

In the period under analysis, the evidence does not indicate any significant changes. But how different is the current situation from that of the past?

The quantitative comparison with bi-regional models developed in previous studies on the subject is not very robust, given the differences of construction and theoretical approach. Nevertheless, in the few cases in which it has been possible to find the necessary information (Ferrara, 1976; Bracalente *et al.*, 1981), the marked dependence of the southern economy in terms of trade balance and production trigger has always been noted.

A comparison that takes into consideration the four macro regions instead of the classical North/South classification – which is made possible by the INTEREG model (Costa and Martellato, 1987) – brings the following evidence: i) there has been over time a general increase in the volume of multiregional trade in both absolute and relative terms; ii) the propensity towards foreign imports has grown in all the macro regions; iii) the North-East and the Centre have started to close the gap in relation to the North-West in terms of multiregional trade, also increasing their integration with the latter macro region; iv) on the other hand the integration capacity of the Southern economy, which between 1975 and 1978 grew in relation to the North-West to the point of overtaking that of the Centre and North-East, has not achieved any significant improvements since then.

The analysis of the backward and the forward linkages, applied to the regions instead of sectors with a simple extension of the Dietzenbacher (1992) procedure, has confirmed that the (few) key Italian regions are mainly located in the Centre-North, while the Southern regions demand and sell a lower amount of intermediate products and thus have low linkages with other regions.

One last methodological observation is worth: the different behaviour that emerges from the analyses performed in terms of triggering of the macro areas – and above all that of the South in relation to the rest of the country – sets the policy makers a problem related to the expediency of utilising solely national models. If it is true that in the design of public intervention on the economy "we have to bear in mind the potential divergence of application in the different territories and prepare appropriate corrective measures ex ante" (Draghi, 2010), then we feel that analyses such as that proposed here can make an important contribution in this direction. Indeed, while a national model may be strongly conditioned by the leading regions, thus concealing the asymmetrical effects of the shocks and the economic policies on the various areas of the country, a model of a multiregional and multi-sector type, such as that used in this study, can take into consideration the interrelations existing between all the elements of a dualistic system such as that of Italy.

Appendix I– The SCM balancing procedure

The Stone, Champernowne and Meade balancing procedure assumes that the initial flows to be balanced are subjected to accounting constraints and can vary according to the relative reliability of preliminary estimate. Instead of the linear bi-proportioning rAs, the concept of variance and co-variance, associated to the reliability of the initial accounting set **T**(0) is explicitly introduced . The solution proposed by the authors consists in a GLS estimator for solving the following problem: given an accounting matrix Γ, or vectorization γ=vec(Γ), subject to a set of constraints v, according to the aggregation matrix G:

$$v = G \cdot \gamma \qquad [a1]$$

Using the initial estimate of Γ, $\gamma(0)$, we obtain:

$$v+\varepsilon = G \cdot \gamma(0) \qquad [a2]$$

Assuming that the initial estimates **t**(0) are unbiased and:

$$\gamma(0) = \gamma(1)+\varepsilon \qquad [a3.1]$$

$$E(\varepsilon) = 0 \qquad [a3.2]$$

$$E(\varepsilon\varepsilon') = L \qquad [a3.3]$$

The use of GLS will lead to the estimate of a vector $\gamma^*(1)$ that will satisfy the accounting constraints in [a1] and will be as near as possible to the actual data $\gamma(1)$. The estimator able to produce such an estimate is the following:

$$\gamma^*(1) = (I - L \cdot G' \cdot (G \cdot L \cdot G')^{-1} \cdot G) \cdot \gamma(0) + L \cdot G' \cdot (G \cdot L \cdot G')^{-1} \cdot v \qquad [a4]$$

It is demonstrated that this kind of estimator is BLU, and its variance is given by:

$$L^* = L - L \cdot G' \cdot (G \cdot L \cdot G')^{-1} \cdot G \cdot \Lambda \qquad [a5]$$

A seminal contribution to the development of the SCM methodology was provided by R.P. Byron (1978). According to the author the estimator SCM can be seen as a solution to a minimization of quadratic loss function of the kind:

$$\zeta = 0.5 \cdot (\gamma^*(1)- \gamma(1))' \cdot L^{-1} \cdot (\gamma^*(1)- \gamma(1)) + \lambda \cdot (G \cdot \gamma^*(1)-v) \qquad [a6]$$

where λ is the Lagrange multiplier. The first class conditions for minimizing the previous equation correspond to the following values of Lagrange multipliers:

$$\lambda^* = (G \cdot L \cdot G')^{-1} \cdot (G \cdot \gamma(0)-v) \qquad [a7]$$

So that the estimator in [a4] will be:

$$\gamma^*(1) = \gamma(0) - L \cdot G' \cdot \lambda^* \qquad [a8]$$

The contribution of R.P. Byron has allowed to overcome one of the problems that had hindered the use of the SCM procedure in the balancing of significant sets of national accounts and SAM, or rather the computational difficulty in inverting the matrix $(G \cdot L \cdot G')^{-1}$. R.P. Byron proposes the conjugate gradient algorithm to reach an estimate of the Lagrange multipliers, by means of the system of linear equations:

$$(G \cdot L \cdot G') \cdot \lambda = (G \cdot \gamma(0)-v) \qquad [a9]$$

Since $(G \cdot L \cdot G')$ is symmetric defined positive, the conjugate gradient method provides a good solution of the λ *coefficients. As also stressed (Nicolardi*, 1999), even with very powerful computers, this method retains advantages compared to direct estimate using [a9] by increasing control provided by the algorithm over possible inconsistencies of the initial estimates Γ and of L and by avoiding the numerical instability tied to the inversion of the sparse matrix $(G \cdot L \cdot G')$.

Appendix 2 – System of balancing identities

The balancing of the MRSUT according to SCM procedure, that is; the single regional SUTs and the multiregional trade matrix **T** is performed simultaneously, through the following system of balancing identities

$$S' \cdot i + T' \cdot i\, m \equiv U \cdot i + F \cdot i + T \cdot i + e \qquad [b1]$$

$$i' \cdot S' \equiv i \cdot U + i \cdot Y \qquad [b2]$$

$$\bar{Y} \equiv Y \cdot G_Y \qquad [b3]$$

$$\bar{F} \equiv F' \cdot i \qquad [b4]$$

$$i \cdot T^* \equiv T^* \cdot i \qquad [b5]$$

$$T^* \equiv \Theta \cdot vec(T) \qquad [b6]$$

$$\sum_{j=1}^{k} \begin{bmatrix} 0 & {}_jU & {}_jF & {}_je \\ {}_jS & 0 & 0 & 0 \\ 0 & {}_jY & 0 & 0 \\ {}_jm' & 0 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 0 & {}_{ita}U & {}_{ita}F & {}_{ita}e \\ {}_{ita}S & 0 & 0 & 0 \\ 0 & {}_{ita}Y & 0 & 0 \\ {}_{ita}m' & 0 & 0 & 0 \end{bmatrix} \qquad [b6]$$

where, k (region), m (sectors), n (products), q (domestic final demand components), p (value added components):
S = blocks-diagonal regional Supply matrices *Supply* $[(k \cdot m)\text{x}(k \cdot n)]$;
i = column vector;

T = multiregional trade matrix $[(k \cdot n) \text{x} (k \cdot n)]$;
m = vector of products foreign import $(k \cdot n)$;
U = blocks-diagonal regional Use matrices $[(k \cdot n) \text{x} (k \cdot m)]$;
$\overline{F}$ = the regional domestic final demand components constraints $[(k \cdot q)]$;
F = blocks-diagonal regional domestic final demand matrices $[(k \cdot n) \text{x} (k \cdot q)]$;
e = vector of products foreign export $(k \cdot n)$;
$\overline{Y}$ = blocks-diagonal regional primary input components constraints $[(k \cdot p) \text{x} (k \cdot m^*)]$;
Y = blocks-diagonal regional primary input components $[(k \cdot p) \text{x} (k \cdot m)]$;
G_y = aggregation matrix from m sectors to m* industry supplied by regional accounts $[(k \cdot m) \text{x} (k \cdot m^*)]$.

Appendix 3 – Sectors in MRIO (Ateco 2002)

A	Agriculture, hunting and forestry
B	Fishing
CA	Mining and quarrying of energy producing materials
CB	Mining and quarrying, non energy producing materials
DA	Food products, beverages and tobacco
DB	Textiles and textile products
DC	Leather and leather products
DD	Wood and wood products
DE	Pulp, paper and paper products
DF	Coke, refined petroleum products and nuclear fuel
DG	Chemicals, chemical products and man-made fibres
DH	Rubber and plastic products
DI	Other non-metallic mineral products
DJ	Basic metals and fabricated metal products
DK	Machinery and equipment n.e.c.
DL	Electrical and optical equipment
DM	Transport equipment
DN	Manufacturing n.e.c.
E	Electricity, gas and water supply
F	Construction
G	Wholesale and retail trade
H	Hotels and restaurants
I	Transport, storage and communication
J	Financial intermediation
70, 71	Business activities, R&D and IT
72, 73, 74	Public administration
L	Education
M	Health and social work
N	Other community, social and personal service activities
O, P, Q	Real estate and renting

Appendix 4 – Multipliers

The economic system drawn by equations [8] in the structural form and by equations [11] and [12] in the reduced form is activated by the final production *pf* at basic prices defined by:

$$pf = T(I - M) \cdot df + ew = R \cdot df + ew \qquad [c1]$$

It is made up by foreign exports *ew* and domestic final demand *df*, coming from the aggregates at purchasing prices (cf. equations [9.*iv*] and [9.*v*]), as these aggregates have a real impact on the economic system. Moreover, domestic final demand is subjected to two different processes before becoming final production: i) leakages in final imports of goods and services from abroad; ii) as the rest of it is distributed among regions through the multiregional trade matrix *T*.

The domestic final demand multipliers, at purchasing prices, are derived from equation [12]:

$$\frac{\Delta x}{\Delta df_{pa}} = INV \cdot R \cdot (I - S_d) \cdot L_{df} \qquad [c2]$$

The multipliers of other endogenous variables, particularly: value added and the imports from abroad, are generated recursively.

The value added multiplier is defined by:

$$\frac{\Delta y}{\Delta df_{pa}} = \hat{V} \cdot INV \cdot R \cdot (I - S_d) \cdot L_{df} \qquad [c3]$$

where the diagonal matrix $\hat{V}$ contains the coefficients $v_{rj} = \frac{y_{rj}}{x_{rj}}$, which represent the value added requirement per unit of production of the sector *j* and region *r*.

The multiplier of the imports from abroad, that sums up the activation of final and intermediate imports of goods and services, is given by:

$$\frac{\Delta mw}{\Delta df_{pa}} = [\hat{M} \cdot (I + INV \cdot R \cdot (I - S_d) \cdot L_{df})] \qquad [c4].$$

In the same way for multiregional imports is:

$$\frac{\Delta mr}{\Delta df_{pa}} = [\widehat{B} \cdot (I - \hat{M}) \cdot (I + INV \cdot R \cdot (I - S_d) \cdot L_{df})] \qquad [c5]$$

and for multiregional export:

$$\frac{\Delta er}{\Delta df_{pa}} = [\breve{B} \cdot (I - \hat{M}) \cdot (I + INV \cdot R \cdot (I - S_d) \cdot L_{df})] \qquad [c6]$$

The multipliers of the endogenous variables allow to specify the trigger of all the components of the national goods and services account in response, for example, either to a change in the domestic multiregional final demand at basic prices *Δdf* (Table C1) or to a variation in foreign exports *Δew* (Table C2).

Table C1 – Triggering of the components of the goods and services account in response to a change of multiregional final demand, at basic prices

GDP	(a)	(b)+(c)
Value added	(b)	$\hat{V} \cdot INV \cdot R \cdot \Delta\, df$
Net indirect taxes	(c)	$\Delta\, df \cdot (S_x \cdot A \cdot INV \cdot R)$
Multiregional imports	(d)	$[\widehat{B} \cdot (I-M) \cdot (I+INV \cdot R)] \cdot \Delta df$
Imports from abroad	(e)	$[M \cdot (I + INV \cdot R)] \cdot \Delta\, df$
Total resources		(a)+(d)+(e)
Internal final demand	(f)	Δdf
Multiregional exports	(g)	$[\breve{B} \cdot (I-M) \cdot (I+INV \cdot R)] \cdot \Delta\, df$
Foreign exports	(h)	-
Total uses		(f)+(g)

Table C2 – Triggering of the components of the Goods and services account in response to a change of foreign exports

GDP	(a)	(b)+(c)
Value added	(b)	$\hat{V} \cdot INV \cdot \Delta ew$
Net indirect taxes	(c)	$\Delta\, ew \cdot S_{ew} + [(S_x \cdot A \cdot INV)]$
Multiregional imports	(d)	$[\widehat{B} \cdot (I-M) \cdot INV] \cdot \Delta\, ew$
Imports from abroad	(e)	$[M \cdot INV] \cdot \Delta\, ew$
Total resources		(a)+(d)+(e)
Internal final demand	(f)	-
Muliregional exports	(g)	
Foreign exports	(h)	Δew
Total uses		(g)+(h)

Appendix 5 – Interregional trade flows and institutional localization

In a system of multiregional trade flows some of them are not related to processes which are endogenous to the economic system and/or to the multi-localization of firms. We are referring to the flows of collective consumption services (CCS)[30], which are generated by the different density of localization of national institutions (or part of them) in some areas of a country.

[30] According to the SEC 1995 classification the production of services by the Public administration satisfies two kind of demands: a) that arising from the household sector for individual consumption, and b) that coming from the whole society (collective consumption). In the COFOG classification the following function of expenses by the Public administration can be defined as collective consumption:

- General public services;
- Defence;
- Public order;
- Economic affairs;
- Environment protection;
- Housing and land use.

It would seem counterintuitive that CCS – like general administration, security, justice and defence – can be exported or imported. Anyway, if the output of these services is compared, for any single region, with the expenses, which are located according to the geographic distribution of the population, it results that most of the regions have a productive deficit while only few of them have a significant surplus.[31] In absence of external flows of CCS, these deficits/surpluses can only be balanced assigning them to interregional imports/exports.

It is not casually that Lazio is the Italian region with the biggest surplus followed by the autonomous border regions. As for Lazio, the Italian capital region, the surplus is due to the presence of central offices of many Public Institutions which produce more services than the needs of the inhabitants of the same region. Regarding the border regions, particularly Friuli-Venezia Giulia, the surplus is generated by a massive production of defence services, due to the diffuse presence of military installations for the oversight of the national boundaries.

In the following table are detailed, with regard to the year 2006 data, the first three regions with the highest CCS surplus and the relative incidence on the total regional exports, and the three ones with the highest CCS deficit on the total regional imports.

Proportion of import and export of CCS, year 2006

First three net exporters of CCS	% of regional export	First three net importers of CCS	% of regional import
Lazio	9.7	Lombardia	4.2
Friuli Venezia Giulia	4.1	Piemonte	2.2
Valle d'Aosta	2.3	Emilia-Romagna	2.1

Source: authors' computations from MRIO-IRPET.

The share of exports of CCS is particularly strong for the regional CCS exports of Lazio (9.7 per cent), while the fraction of Friuli-Venezia Giulia is slightly lower (4.1), descending from 7.0 per cent in the year 1995. The incidence of imports of CCS is significant for Lombardy (4.2 per cent), followed by Piedmont and Emilia-Romagna.

The interregional flows of CCS have a significant effect also on the net regional balances. For example, should the export of CCS from Lazio become zero, the net regional exports would change their sign from positive to negative. Obviously, this has consequences on results referred to geographic macro areas (cf. Table 2).

[31] In the adopted balancing procedure both the expenses of the Public administration and the production of its services come from the regional economic accounts by Istat; for this reason they are treated like constraints.

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Forecast for the Development of the Russian Economy for 2012-2015 Using the Dynamic Input-Output Model[1]

Recent developments of World economy

In 2011, the rates of world economic development slowed down. According to the data of IMF analytical report, the US GDP has grown on 1,7% as compared with 3% in 2010. EU economy has grown on 1,6% as compared with 2% in 2010. Euro Zone GDP growth rates in 2011 was 1,5% in comparison with 1,9% in 2010. Chinese GDP in 2011 has increased on 9,2% as compared with 10,4 % in 2010. In 2011 in Japan was recession: GDP has decreased on 0,7% whereas in 2010 Japan economy has increased on 4,4% (see table 1). In total world GDP growth rate essentially fell from 5,3% in 2010 to 3,9% in 2011[2].

In nearest future the deceleration of world economy growth rates is expected: from 5,1-5,2% before 2008-2009 crises to 3,5%-3,9%[3].

The deceleration of economic growth rates or recession in the short-term and medium-term periods are connected with a high level of uncertainty concerning the prospects for the development of leading world economies, which is due to a great national debt in a number of EU countries and the USA and low rates of economic growth in Japan.

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[2] World economic outlook: a survey by the staff of the International Monetary Fund, URL: http://www.imf.org/external/pubs/ft/weo/2012/update/02/ date of treatment 18.07.2012.

[3] URL: http://en.wikipedia.org/wiki/Gross_world_product date of treatment 20.07.2012.

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At the same time, the power of the governments of a number of the largest countries to apply the instruments of economic policy is limited. The US FRS discount rate is within the range of 0-0,25%, the discount rate of the European Central Bank is 1,5%, of the Bank of England 0,5%, and that of the Bank of Japan 0,0-0,1% per annum, while inflation in the USA, Euro Zone and the UK exceeds the level of the discount rates.

Table 1 – GDP growth rates in leading economies and in Russia in 2010-2012, %

	2010	2011	2012
World economy	5,3	3,9	3,5
USA	3	1,7	2,0
EU	2	1,6	0
including EURO Area	1,9	1,5	-0,3
China	10,4	9,2	8,0
Japan	4,4	-0,7	2,4
Russia	4,3	4,3	4,0

Source: World economic outlook: a survey by the staff of the International Monetary Fund, URL: http://www.imf.org/external/pubs/ft/weo/2012/update/02/ date of treatment 18.07.2012

In other words, the central banks of the leading world economic centers keep real discount rates equal to zero or negative. For this reason, the leading world economies are in the situation or close to the situation of "a liquidity trap" when real interest rates in the economy are very low and their adjustment has very little influence on the behavior of economic agents, the situation which was described in the economic theory long ago. That is why, in our opinion, in these conditions it is hard to expect considerable positive consequences from manipulating the money supply and interest rates in the economies of the USA, EU, and Japan.

On the other hand, the governments' of the USA, Japan and some other countries of the EU that have great national debts (that in some cases greatly exceed the GDP, for example in Greece and Italy) are limited in their ability to stimulate economic growth by applying fiscal measures.

These factors make it possible to draw a conclusion that in the short-term and medium-term periods there is a high likelihood to expect low growth rates of the world economy or another decline similar to the recession of 2008-2009. This fact predetermined the philosophy of forecasting the economic development of Russia for the period 2012-2015, with the trajectory of economic growth projected within the range of basic or moderately optimistic (moderate rates of growth) and pessimistic alternatives.

Hypotheses Employed in Making a Forecast

The econometric analysis, which employed the quarterly data describing the dynamics of the most important real (i.e. net of inflation) [4] macroeconomic variables in Russia, shows that in the recent decade the following changes have had a crucial effect on the dynamics of GDP:

- Real money supply M2 (a positive effect with a 1 quarter lag);
- Price of Urals oil brand (a positive effect with a 1 quarter and 4 quarter lag.

Basic scenario. It is predicated on the main idea of the absence of radical economic or political shocks in the forecasting period. It is assumed that the plan for gradually leading some of the union member countries out of the debt crisis adopted under the direction of the EU will be carried out step be step.

The US Federal Reserve System and government continue taking measures to provide economic growth and reduce inflation. The Chinese leaders manage to avoid the overheating of the national economy, which will ensure the stability of their financial markets and continuation of steady economic growth in the country. All of these factors will gradually have a more and more positive influence on the expectations of economic agents all over the world. A gradual recovery of the European and American economies as well as continuing stable economic growth in China will ensure positive dynamics in the development of the world economy in the forecasting period that will provide stable prices on of Russia's main exported goods and create favorable external conditions for the development of the Russian economy in general.

It is forecast that the Russian leaders will carry out a reasonable economic policy taking advantage of the positive external conditions in order to ensure accelerated economic growth. The struggle for reducing inflation that is being carried out by the Bank of Russia will not lead to a considerable decrease of real money supply, a noticeable growth of interest rates and will not provoke recession. The Federal government will continue stimulating economic growth by increasing state expenditures on the development of infrastructure, the innovative and defense sectors. Real incomes of the population will continue to grow gradually. As expenses on final consumption of households account for approximately one half of Russian GDP, it will significantly contribute to building up stable economic growth.

As regards the dynamics of some key forecasting parameters, the following assumptions were taken for this scenario:

[4] The deflation was carried out with the help of GDP deflator that is determined as a ratio of nominal GDP growth rates to real GDP growth rates for each year.

The period 3-4 quarters 2012

Under the basic scenario it is assumed that in 3-4 quarters 2012 the average Urals oil brand price will be at the same level as average level of 2nd quarter of 2012, i.e. approximately $ 107 per barrel.

The Bank of Russia will provide such growth of nominal money supply that in 3rd 2012 it will lead to a gradual increasing of the volume of real money supply M2 by 20% and by 10% in 4th quarter 2012. Under the assumption that GDP deflator in 2012 will increase by 9,3% (average deflator for 2010-2011) volume of nominal money supply M2 in 2012 will increase by 26%. It's comparable with increase of nominal money supply M2 in 2010 (32,9%) and in 2011 (23,8%).

The period 2013-2015

Under the conditions of EU and world economy recovery Urals oil brand price will increase gradually. In 4th quarter of 2013 it will be 5% higher as compared with its average level in 2-4 quarters 2012. In 2014 Urals oil brand price will increase by 10% and in 4th quarter 2014 will be equal $ 123,5 per barrel. Gradual growth of oil price is forecasted for 2015 (by 10% per year). Average oil price for 2013 is assumed on the level of $ 110 per barrel and is equal to average oil price which is forecasted for 2012. In 2014 average Urals oil brand price is forecasted on the level of 119 per barrel and for 2015 - $ 131 per barrel.

The Bank of Russia will continue to provide active monetary police. It will increase real money supply M2 by 10% in 2013 and by 5% in 2014-2015. Under the assumption that GDP deflator in 2012 will increase by 9,3% (average deflator for 2010-2011) volume of average nominal money supply M2 in 2013 will increase by 20,2% and by 14,7% in 2014-2015.

In general, the basic scenario can be characterized as moderately optimistic. The word "moderately" primarily refers to the rates of growth of investments into fixed capital. According to our estimates, in order to ensure an accelerated renewal of fixed capital in Russia and, first of all, its active part (machines and equipment), the rate of growth of investments into fixed capital should be not less than 14%-15% per year[5].

Only under such growth rates of investments can we expect a qualitative leap in labour productivity that will enable Russia to gradually approach the level of efficiency of the economies of developed countries.

[5] Baranov, A. O., Pavlov, V. N., "Forecasting the Development of Russian Economy Using of a Dynamic Interindustrial Model with Fuzzy Parameters", *Socio-economic Sciences*, Vol. 7, issue 3, pp. 3-14 (In Russian), NSU Vestnik, 2007.

Pessimistic Scenario. It is predicated on a negative development of the world economy in short and medium-term perspectives. The essence of the negative scenario of development is as follows:

- In spite of the fact that a considerable part of the state debt of Greece was written off in autumn 2011 (which, in fact, means partial default already), the country will not be able to service the outstanding debt. The other countries of the Euro Zone will refuse to finance the Greek debts and exclude the country from the Euro Zone or Greece will leave it voluntarily. Another potential shock that may provoke the beginning of a new financial-economic crisis is connected with the deterioration of the state debt problem of Spain, one of the largest European economies. Distrust towards the country's state securities and its possible default can also provoke panic at stock exchanges and lead to destabilization of the world economic system.
- The negative development scenario in the market of European public debt obligations leads to a sharp fall of trust to the Euro as one of the world reserve currencies, the rate of the Euro in relation to other world currencies is depreciated. There is a sharp fall in the price of all assets nominated in the currency, a fall in the price of state securities of problem European countries in particular, whose state debt exceeds or is equal to the size of their annual GDP – Portugal, Ireland, Italy. The assets of the largest European banks and corporations decrease drastically.
- Due to the depreciation of European assets investors start a mass sale of securities of European banks and corporations. It leads to the beginning of a collapse at European stock exchanges.
- A number of largest European banks – holders of large packages of state securities of problem countries – go bankrupt. In order to prevent a complete collapse of the financial system the banks are nationalized by the governments of the EU countries.
- The panic at European stock exchanges spreads all over the world. The crisis of the European financial system leads to a sharp fall of trust among the financial institutes of the whole world economy and, in effect, stops inter-bank crediting in the USA, Japan, China, in the BRIC counties and the rest of the world.

Similarly to the events in 2008-2009, the financial crisis is followed by the economic crisis: the decline of production in the European countries leads to a decrease of aggregate demand on world commodity markets. As at, result, there is a decline of production in the USA and a reduction of economic growth rates in China. In the end of 2012, a new world economic crisis sets in.

- The slump in the world production will lead to a decrease of demand on Russian exported goods and the prices and sales volumes of Russian main exported goods will fall considerably. This will result in a sharp fall of the surplus of current account operations of the balance of payments. In addition, as in 2008-2009, the consequence of the crisis of the world financial system will be a sharp reduction or suspension of crediting Russian banks from abroad. The supply of credits in Russia will decrease, which will lead to a reduction of real money supply. As it happened in 1998 and the autumn of 2008, Russia will face a massive flight of speculative capital that will sharply increase a negative balance of the capital account of the balance of payments. There is a high likelihood that in general the balance of payments will be either negative or balanced.
- In 4th quarter 2012 and in 2013, the fall of demand on exported goods, the reduction of the size of credits and the flight of capital will lead to a slump of production in Russia
- In 2014, the fiscal and monetary measures of stimulating economy will prevent a further fall of production in the largest economies of the world. At the same year, a structural reorganization will take place in the economies of the leading countries that will ensure the growth of production effectiveness and the beginning of economic recovery in 2014-2015.

The dynamics of some key forecasting parameters for the pessimistic scenario were built on the following assumptions.

3-4 quarters 2012

In 3-4 quarters 2012 г. the average Urals oil brand price will decrease by 10% as compared with average price in June 2012 ($ 93,4 per barrel). Average Urals oil brand price in 3-4 quarters will be approximately $ 84,1 per barrel.

At the same time the Bank of Russia will not provide active monetary police. The real money supply M2 *will not increase* in 3-4 quarters 2012.

2013-2015

Urals oil brand price un 2013 gradually will decrease to $ 100 per barrel in 4th quarter 2013, i.e. by 20% as compared with 3-4 quarters 2012. In 2014 oil price will increase by 10% and will achieve $111 per barrel in 4th quarter 2014. In 2015 oil price will increase gradually by 10% again and will achieve $ 122 per barrel in 4th quarter 2015.

In 2013 real money supply M2 will increase by 10 %. In 2014-2015 for economic recovery the Bank of Russia will provide more aggressive monetary policy and will increase real M2 money supply by 20% per year. It means 27% growth of nominal money supply under condition that annual GDP deflator will be 6.

Analysis of Estimated Results

The forecast for the development of the Russian economy for the period 2012–2014 was carried out with the help of econometric methods and the dynamic inter-industry model of the Russian economy for 64 industries (32 industries of the first division and 32 of the second one). Table 2 as well as Figures 1, 2, 3 illustrate the rates of growth of a number of key macroeconomic indices for the period 2012 -2014 under two forecasting scenarios. The main conclusions of the results of the projected estimates are as follows:

- In the next few years the Russian economy will be still greatly dependent on the dynamics of the world market of energy resources, primarily oil. This widely known fact is supported by the forecasting quantitative estimates that demonstrate a great volatility of major macroeconomic indices of the Russian economy in the conditions of a considerable oil price variation. According to our estimates, *in the absence of an effective stimulating monetary policy on the part of the Bank of Russia and fiscal policy on the part of the government of the Russian Federation, with the dynamics of oil prices corresponding to the pessimistic scenario, the fall of GDP in the Russian economy in 2013 can account for approximately 1,5%. Under this scenario, in 2014 the growth of GDP will be only about 1%. A considerable positive development of the Russian economy will be restored only in 2015 when the growth rate may amount to 4,1%.* In 2013 the gross output of the first division will fall by 1,7% and of the second one by 1,2% (see Table 2, figures 1 and 2).
- Within the framework of the scenarios under review, investments into fixed capital will experience the most considerable variations among the analyzed macroeconomic indices. Under the pessimistic scenario, they might fall by 4% in 2013. In the basic scenario for economic development, the growth rates of investments into fixed capital vary from 110% in 2012-2013 to 112% in 2014-2015 (see Table 2, figure 3).

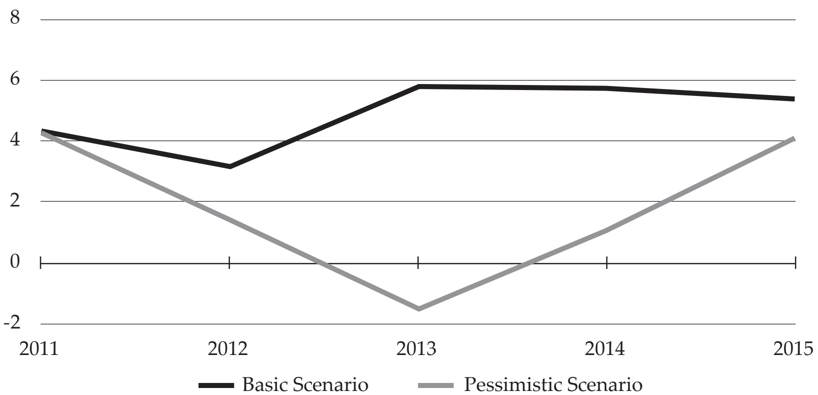
As noted above, the basic scenario is moderately pessimistic. This scenario does not presuppose the growth rate of investments into fixed capital (not less than 14%-15% per annum) that could provide an appropriate level of compensation for a drop out of the active part of fixed assets that are important for ensuring such rates of growth of production efficiency that would provide a reduction of a considerable gap between Russia and the developing countries on this index. Such rates of investments growth would require higher rates of growth of GDP (9%-11%) or a reduction in the growth rates of the production of consumer goods and services, i.e. a redistribution of resources from the first subdivision into the second one. The latter is unacceptable in view of a rather low living standard of the population in Russia in comparison with that in the developed countries.

Table 2 – Urals oil price ($US/bar.) dynamics and growth rates of some macroeconomic indices of the Russian economy for the period 2011-2015, %

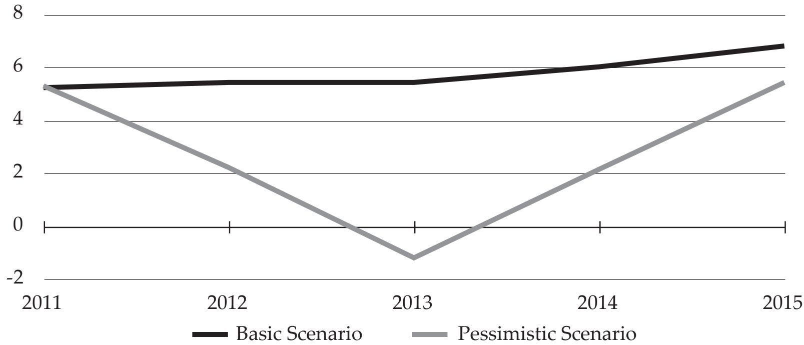
Indices	2011	2012	2013	2014	2015	2012-2015, *growth rate, %*
Average Urals oil price, $ US/barrel						
Basic Scenario	109,1	109,6	110,3	119,2	131,2	120,2
Pessimistic Scenario	109,1	98,1	94,4	107,1	117,9	108,0
GDP growth rate, %						
Basic Scenario	104,3	103,2	105,8	105,8	105,4	121,6
Pessimistic Scenario	104,3	101,4	98,5	101,1	104,1	105,1
Capital and intermediate goods production growth rates, %						
Basic Scenario	103,8	102,0	106,0	105,6	104,6	119,3
Pessimistic Scenario	103,8	101,0	98,3	100,5	103,4	103,1
Consumer goods production growth rates, %						
Basic Scenario	105,3	105,4	105,5	106,0	106,8	125,9
Pessimistic Scenario	105,3	102,2	98,8	102,2	105,5	108,9
Investments into fixed assets growth rate, %						
Basic Scenario	108,3	110,0	110,0	112,0	112,0	151,8
Pessimistic Scenario	108,3	106,2	96,0	102,0	110,0	114,4

Source of information: results of forecast using macroeconomic econometric model and Dynamic Input-Output Model.

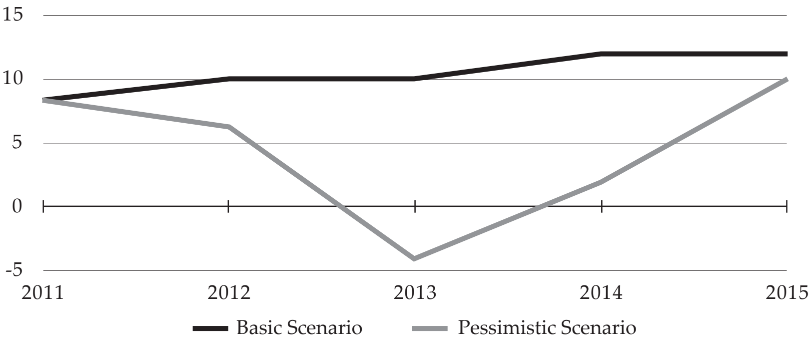
Graph 1 – Russian economy real GDP growth rate in 2011-2015, %



Graph 2 – Consumer goods production growth rate in Russian economy in 2011-2015, %



Graph 3 – Investment growth rate in Russian economy in 2011-2015, %



In our view it is possible to provide a required level of investments into fixed capital through attracting considerable foreign investments. However, in the next few years a massive inflow of investments will be limited by high uncertainty in the prospects for world economic development caused by the consequences of financial-economic crisis of 2008-2009 that have not been overcome yet.

A comparison of the projected dynamics in different types of economic activity according to different forecasting scenarios makes it possible to draw the following conclusions.

1. Depending on different development scenarios, fund-forming industries experience the greatest fluctuations in the volumes of production. Under the pessimistic scenario, the rates of growth in machine building during total period under consideration (2012-2015) are 44,6% lower than those under the basic scenario (Tables 5). In construction the growth rates during total period under consideration (2012-2015) are 31,7% lower than those under the basic scenario (Tables 5). This volatility

is quite understandable taking into account great fluctuation amplitude in the growth rates of investments into fixed capital, whose tangible "material filling" is made up by the products of fund-forming industries.

2. A comparison of the volatility dynamics in the extraction of mineral deposits and processing industries according to different forecasting scenarios shows a much higher fluctuation in the latter (see Tables 3-5). It is explained by a high volatility in the growth rates in machine building, production of construction materials, textile and sewing production and manufacture of finished hardware (Table 5). The above-mentioned types of economic activity, excluding textile and sewing manufacture, refer to the investment complex that accounts for approximately one fifth part in the gross output of processing industries.

3. At first sight, the rather insignificant, according to different variants of development, fluctuations of the gross output growth rates in extracting industries might seem paradoxical. However, it can be explained by rather stable production growth rates in these industries measured in *constant prices*. For example, in the crisis year of 2009, the gross output of the economic activity "Extraction of crude oil and natural gas, rendering of services in these industries" did not fall but increased by 1,1% in comparable prices.

A comparison of the projected rates of production growth by industries make it possible to see how the mechanism of the negative influence of external shocks on the dynamics of the Russian economy works. In general terms its essence is as follows: reduction of aggregate demand on world markets and reduction of prices on exported goods → reduction of net export, the balance of payments surplus and of currency earning → decrease of earnings (sales volumes) in export-oriented industries → ruble devaluation and collapse of the stock exchange market → massive flight of Russian and foreign capital out of the country → reduction of money supply → increase of interest rates in the economy → fall of internal aggregate demand that starts in industries of the investment complex → fall of total production output or reduction of production growth rates → considerable reduction of incomes in the extended budget and budget deficit. In other words, external shocks affect the economy of Russia not only through the industries of the extracting branch, but also through the financial market where the negative dynamics transform into a decline in production, increase of unemployment and budget deficit.

The government of Russia cannot influence the situation in external markets in any significant way. For this reason, under the adverse development of the situation in the world fuel markets, the mechanisms of stabilizing the Russian economy are those connected with regulating currency, stock and monetary markets as well as stimulating the economy by fiscal instruments.

In general, according to our estimates, the most likely trajectory for the development of the Russian economy in 2012-2015 will be within the boundaries of the development dynamics of the main indices of the basic and pessimistic scenarios.

Table 3 – Gross output growth rates for different kinds of economic activities in Russia in 2012-2015 in accordance with the basic scenario forecast, %

Kinds of Economic Activity	2012	2013	2014	2015	2012-2015
1. Agriculture, hunting, forestry and fishing	103,5	105,1	105,2	105,5	120,7
2. Minerals mining	99,5	103,5	102,2	100,7	105,9
3. Manufacturing	102,3	106,1	106,0	105,4	121,2
including machine – building industry	106,2	108,6	111,9	112,0	144,6
4. Production and distribution of electric power, gas and water. Water collection, purification and distribution	101,8	105,5	104,8	104,1	117,1
5. Construction of buildings and facilities	108,4	109,2	110,9	110,8	145,4
6. Wholesale and retail trade, repair, hotels and restaurants	103,7	105,3	105,5	105,8	121,8
7. Transportation	102,5	105,2	104,9	104,6	118,3
8. Communication	102,8	105,4	105,0	104,8	119,3
9. Financial activities	110,5	105,4	104,3	103,4	125,7
10. Real estate transactions, renting and services	102,7	105,5	104,8	104,3	118,4
11. Public administration, military security. Social security, education, health and socila services, other utilities, social and personal services	104,2	105,5	105,8	106,2	123,4

Source of information: results of forecast using dynamic input – output model of Russian economy.

Table 4 – Gross output growth rates for different kinds of economic activities in Russia in 2012-2015 in accordance with the pessimistic scenario forecast, %

Kinds of Economic Activity	2012	2013	2014	2015	2012-2015	Difference *v.* Basic Scenario for the period 2012-2015
1. Agriculture, hunting, forestry, fishing	100,8	99,2	101,9	104,4	106,3	-14,4
2. Minerals mining	99,2	100,4	100,4	100,5	100,3	-5,6
3. Manufacturing	101,1	97,7	100,3	104,0	103,0	-18,2
including machine – building industry	106,8	90,1	95,8	108,4	100,0	-44,6
4. Production and distribution of electric power, gas and water. Water collection, purification and distribution	100,1	99,0	101,1	103,3	103,4	-13,7
5. Construction of buildings and facilities	105,2	96,5	102,7	109,1	113,7	-31,7
6. Wholesale and retail trade, repair, hotels and restaurants	101,1	98,9	101,8	104,6	106,5	-15,3
7. Transportation	100,6	99,1	101,4	103,6	104,7	-13,6
8. Communication	100,6	99,2	101,6	103,9	105,3	-14,0
9. Financial activities	108,7	99,7	101,3	102,8	113,0	-12,8
10. Real estate transactions, renting, services	100,6	99,3	101,4	103,5	104,9	-13,4
11. Public administration, military security. Social security, education, health and socila services, other utilities, social and personal services	101,3	98,9	102,0	105,0	107,2	-16,2

Source of information: results of forecast using dynamic input – output model of Russian economy.

Table 5 – Gross output growth rates for different kinds of economic activities in Russia, with a more detailed description of different kinds of industrial activities, for the total period of 2012-2015 in accordance with different forecasting scenarios,%

Kinds of Economic Activity	Scenarios		Difference *vs.* Basic Scenario for the period 2012-2015
	Basic	Pessimistic	
1. Machine – building industry	144,6	100,0	-44,6
2. Construction	145,4	113,7	-31,7
3. Agriculture, hunting, forestry and fishing	120,7	106,3	-14,4
4. Extraction of gas	108,7	101,4	-7,3
5. Extraction of oil	102,9	99,8	-3,1
6. Other minerals mining	115,9	102,1	-13,8
7. Foodstuffs and tobacco production	124,8	107,7	-17,1
8. Textile and Sewing production. Leather - Footwear Industry	125,4	89,4	-36,0
9. Wood processing industry. Pulp and paper industry. Publishing and printing industry	117,7	103,6	-14,1
10. Coke production	111,6	101,6	-10,0
11. Petroleum products production	113,6	102,6	-11,0
12. Chemical production. Rubber and plastic products production	117,5	101,9	-15,6
13. Construction materials production	137,0	109,6	-27,4
14. Ferrous metals production	116,3	100,6	-15,7
15. Non-ferrous metals production	105,7	98,6	-7,1
16. Hardware production	124,0	103,1	-20,9
17. Other kinds of industrial activity	115,1	103,1	-12,0
18. Production and distribution of electric power, gas and water. Water collection, purification and distribution	117,1	103,4	-13,7
19. Wholesale and retail trade, repair, hotels and restaurants	121,8	106,5	-15,3
20. Transportation	118,3	104,7	-13,6
21. Communication	119,3	105,3	-14,0
22. Other services	122,0	107,3	-14,7
GDP - Total	121,6	105,1	-16,5

Source of information: results of forecast using dynamic input – output model of Russian economy.

J. Richter

Assessing the impact of an increase in tourists' expenditure

Introduction

In the Austrian INFORUM model AEIOU II[1] expenditures of foreign tourists are shown as a separate category of final demand. This isolation of non-resident private households has a long tradition in Austrian INFORUM Models and permits to treat their consumer expenditure different from the expenditure of resident (Austrian) households. In contrast to the consumer expenditure of Austrian residents foreign tourists' expenditure are treated exogenously.

In a study published by the Austrian Institute for Economic Research in 2010 (SMERAL 2010) it is argued that under certain conditions there is a good chance that foreign tourists' expenditure might grow faster than in the recent past and assumed in the Base Case Scenario of AEIOU II.

The findings and considerations included in this study were taken as a starting point for carrying out two simulation exercises with the help of AEIOU II. Both simulations are devoted to the quantification of the impli-

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[1] The team responsible for the development of AEIOU II consisted of Florian Schwendinger, Christian Sommeregger, Josef Richter, Margit Reischer, Alexander Erdelyi and Dieter Gstach (project leader). Josef Richter carried out the simulation exercises with respect to an increase in tourists' expenditure.

The suggestions and assistance provided by Clopper Almon and Maurizio Grassini during visits in Vienna contributed significantly to the success of the project. The help of many INFORUM staff members in Maryland was indispensable for linking AEIOU II to the INFORUM world model and helped to improve the model during a visit of Florian Schwendinger and Christian Sommeregger in College Park; Maryland. In addition Mikulas Luptacik and Bernhard Böhm made valuable contributions particularly to the model specification. The work would also not have been possible without the assistance of many staff members of Statistics Austria.

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cations of such an additional growth on the Austrian economy as a whole and on the various industries and products, on quantities as well as on prices. The two alternative Scenarios presented here differ – compared to the Base Case Scenario – only with respect to the assumptions on total expenditures of foreign tourists in Austria, the structure of these expenditures and with respect to the input structure of industry NACE 55 *Hotels and restaurants*.

The exercise for the period 2008 to 2030 made it very clear that it is not sufficient to limit the analysis to the effects on the macro level. The implications on the level of industries and products groups are pronounced and deserve special attention. The range of differences by industries and/or product groups is quite remarkable. The investigation underlined that in order to study the manifold effects induced by a final demand category with a very specific commodity structure a disaggregated approach is indispensable.

In order to illustrate the potential of an instrument like an INFORUM model in a second part of the contribution the simulation results are confronted with the outcomes of two standard approaches to assess the impact of an increase in tourists' expenditure. In the first approach the increase in tourists' expenditure is analysed in an isolated way. In the second approach the effects of an increase in tourists' expenditure is analysed in its repercussions on the production with the help of the standard static open Leontief model but without considering the income and price effects. It will be shown that the three approaches lead to very different results both with respect to the overall effects and with respect to the structural pattern induced.

Simulations with AEIOU II – Increase in tourism expenditure

A short description of the model AEIOU II[2]

AEIOU II can be seen as a typical INFORUM model based on the general modelling philosophy as described i.e. in Almon (1991, 1995, 2008), Grassini (2001, 2008) and Meade (2001). All macro variables are calculated in a bottom-up approach starting from the details. Emphasis is laid on a disaggregated and consistent accounting framework and on a sound empirical foundation.

AEOIOU II consists of a demands side and a price side which are solved simultaneously in an iterative process. Consumption, capital formation, imports, employment and prices are endogenously determined.

[2] The short description is based on the detailed (but unpublished) model documentation (Schwendinger, Sommeregger, Richter, Reischer, Erdelyi, Gstach 2011).

Endogenous determination of prices is one of the biggest improvements of AEIOU II compared to the earlier Austrian INFORUM model AEIOU I (see Böhm, Richter 2007).

AEIOU II Is linked to the INFORUM Bilateral Trade Model (BTM)[3] as a satellite. AEIOU II uses BTM information as regards demand for Austrian exports and Austrian import prices.

Accounting framework

The statistical core of the model is the official Austrian input-output table for 2005 (STATISTIK AUSTRIA 2009). The table distinguishes 57 industries and 57 groups of products according to the European standard classifications NACE Rev. 1[4] and CPA[5]. Because of analytical considerations the table was disaggregated to a 60 by 60 breakdown, by splitting up CPA 40 and CPA 70 in the following way:

- CPA 40 Energy,
  - 40.1 Electricity,
  - 40.2 and 40.3 Gas, steam and hot water,
- CPA 70 Real estate services
  - Real estate services - market,
  - Real estate services - owner occupied,
  - Real estate agency services.

Final demand is also treated in a more disaggregated way compared to the official table. The following categories are distinguished:

- Final consumption expenditures
  - Private consumption expenditure, Austrians in Austria,
  - Private consumption expenditure, Foreigners in Austria,
  - Final consumption expenditure by government,
  - Final consumption expenditure by NPISH,
- Gross fixed capital formation
  - Dwellings - market,
  - Dwellings - non market,
  - Other buildings and structures,
  - Machinery NACE 1-37 and 45,
  - Machinery NACE 40 and 41,
  - Machinery NACE 50-55,
  - Machinery NACE 60-65,
  - Machinery others,

[3] For a description of the BTM system see i.e. Nyhus (1991) and Ma (1995).
[4] Council Regulation (EEC) (1990).
[5] Council Regulation (EEC) (1993) .

- Transport equipment NACE 1-5,
- Transport equipment NACE 10-55,
- Transport equipment NACE 60 and 61,
- Transport equipment NACE 62,
- Transport equipment others,
- Intangible fixed assets NACE 92,
- Other intangible fixed assets,
- Cultivated assets,

• Changes in valuables

• Changes in inventories

• Exports
  - Merchandise goods,
  - Services.

In value added the following components are distinguished:

• Compensation of employees,

• Other net taxes on production,

• Consumption of fixed capital,

• Operating surplus, net.

As regards time series, most of time series from Statistics Austria covered the period 1976 to 2008. The chain-weighted volume indices had to be transformed into series at constant prices 2005.

Demand side

The estimation of private consumer expenditure of Austrian private households is based on a set of behavioural equations in a breakdown by CPA. The share of good i in total consumption is seen as a function of the relative price of good i and the consumption share of the previous period. Aggregate consumption in real terms is treated as a function of real disposable income of private households, contemporaneous and lagged and the lagged value of the dependent variable.

Private consumption expenditure of foreigners in Austria, final consumption expenditure by government and final consumption expenditure by NPISH are treated exogenously. The estimation is based on historic trends on the level of the various product groups.

As regards the estimation of gross capital formation 15 categories are distinguished in order to reduce the complexity of the model and to ensure full utilization of the available information. As might be seen from the list presented above the15 categories represent rather homogeneous types of capital formation. All equations include one or more lagged endogenous variables. A further, but somewhat unusual regressor is the product of the depreciation rate and investment (lagged one period). This variable has proven in testing to perform better than capital stocks. One might interpret this variable as a proxy for replacement investment, which is the more valid, the faster the underlying depreciation process is. Additional regressors are the real output of the investing industries.

The final demand categories cultivated assets, changes in valuables and changes in inventories are again treated exogenously.

Most of the regression equations for describing the change in shares of imports in total demand use relative import prices and the log-version of the Nyhus-trend variable. On the demand side imports play a crucial role in order to calculate output, on the price side the import matrix is needed to calculate domestic prices. Therefore, the import matrix is updated every year in order to keep the import matrix (and the respective share matrices) consistent with estimated total imports.

A simple accountant for the sector "Private households and NPISH" bridges between the incomes generated in the production process to personal disposable income of private households. Disposable income of Austrian residents is then used as explanatory variable to determine aggregate consumption.

Price side

The price side is based on the traditional cost-push philosophy. The estimation of employment and of wages by industries plays the key roles for all model results.

As it in many other INFORUM models the process of arriving at unit labour costs per industry is done in two separate steps. In the first step the persons employed per industry are estimated. In a second stage the corresponding wage rates in nominal terms are derived to arrive at wage bills per industry. The wage rate of an industry is seen as a simple, linear function of the overall wage rate.

Depreciation by industry is estimated as a function of the depreciation level in this industry and the (lagged) investment level of the industry. The very low shares of production related indirect taxes in total nominal output are kept constant at the respective 2005 values.

To determine the operating surplus a mark-up approach is used. The mark-ups (the proportions of operating surplus in total output) are treated exogenously based on the average of these shares over the past decade.

The import prices (very relevant for a small open economy like Austria) were made available from the international system of interlinked INFORUM models.

Base Case Scenario

Assumptions

As already mentioned foreign tourists' expenditure are treated exogenously in AEIOU II. The Base Case Scenario relies on the hypothesis that the future development will correspond to the average development in real terms over the last 10 to 13 years, taking the pronounced product specific differences in growth into account. In addition it was assumed that very high growth rates observed in the past will level out to a growth rate of 2% in the medium term. Such a levelling-out effect was in particular introduced for the product groups:

3| 05 Fish, other fishing products[6]
13| 21 Pulp, paper and paper products
40| 62 Air transport services
41| 63 Supporting transport services, travel agency services
42| 64 Post and telecommunication services
54| 80 Education services
55| 85 Health and social work services

It deserves mentioning that for the product group *37| 55 Hotel and restaurant services* – the product group with the highest share in total foreign tourists' expenditure – no growth or decline was assumed for the entire simulation period up to 2030.

The consumption of gasoline and diesel by non-residents it to a high degree dependent on the differences in prices between neighbouring countries. In the past strong upwards and downwards movements were observed. The scenario relies on the assumption that the price relations between Austria, Germany and Italy remain more or less stable at the present level. The underlying hypothesis for the period up to 2030 is a very moderate growth.

For the purpose of the present simulations the results of the Base Case Scenario only serve as a reference solution of the model. Therefore they are not presented separately.

Alternative A – Higher Growth

Assumptions

The two alternative Scenarios presented here differ – compared to the Base Case Scenario – only with respect to the assumptions on total expenditures of foreign tourists in Austria, the structure of these expenditures and with respect to the input structure of industry NACE 55 *Hotels and restaurants*.

[6] The first index refers to the current number in the model, the second to CPA.

This Alternative A scenario takes the basis scenario of the study published by the Austrian Institute for Economic Research as a starting point. This scenario assumes an annual growth of 1,7% in real terms for the period 2009 to 2015. The author of the study Smeral (2010) argues that this somewhat higher growth than in the recent past should be possible if Austria can at least keep the market shares in the major markets from which the tourists come to Austria constant on the level observed in 2009. The resulting growth can still be considered rather moderate, the main reason being that most of the foreign tourists come from Germany, the Netherlands, Switzerland and Italy, countries with below the average growth rates in tourism expenditures of households[7].

For the purpose of the present simulation a few small modifications in the exogenous estimate of foreign tourists' expenditure were made.

Slightly higher growth of expenditure than in the Base Case Scenario was assumed for:

38| 60 Land transport and transport via pipeline services
40| 62 Air transport services
41| 63 Supporting transport services, travel agency services
42| 64 Post and telecommunication services
55| 85 Health and social work services
58| 92 Recreational, cultural and sporting services

These modifications were introduced to pay more attention to the trend towards more short term visits and towards trips because of health and wellness considerations and because of cultural events[8].

The small increase in expenditure for services of hotels and restaurants (+1% per annum in contrast to the zero growth in the Base Case) is almost sufficient to arrive at the growth rate of the base case of the SMERAL study.

Very high product specific growth rates observed in the past were only accepted for the period up to 2015, the end year of the Smeral study. For the period 2016 to 2030 the standard levelling-out procedure was applied.

The additional growth compared to the Base Case Scenario is associated with a higher utilization of existing capacities, primarily in hotels and restaurants and an increase in quality of the services. These two tendencies had to be translated into changes in the input structure of industry NACE 55 *Hotels and restaurants*.

The tendency towards higher quality is reflected in small increases in the technical coefficients for the following product groups:

9| 17 Textiles
18| 26 Other non-metallic mineral products
28| 36 Furniture, other manufactured goods n.e.c.
33| 45 Construction work

[7] For details see Smeral (2010), in particular chapter 4.2.
[8] For details see Smeral (2010), in particular chapter 5.2.2.4.

42| 64 Post and telecommunication services
50| 72 Computer and related services
55| 85 Health and social work services
58| 92 Recreational, cultural and sporting services
59| 93 Other services

The need to make more use of information and communication technology was also taken into account[9].

Some of the inputs are relatively independent of the level of the output of industry NACE 55 *Hotels and restaurants*. Consequently better capacity utilization will lead to a decrease in the relevant input coefficients. Such a development was in particular assumed for:

46| 70AM Real estate services - market
52| 74 Other business services
57| 91 Membership organisation services n.e.c.

Also due to the better capacity utilization it was assumed that the share of operating surplus will rise; in the case of labour compensation it was supposed that the effect of better capacity utilization and the trend towards better qualified staff will cancel out.

Results

Table 1 shows the main macro results relative to the Base Case Scenario. As mentioned in the introduction the emphasis is on deviations from the Base Case. The entries in Table 1 relate the absolute values of the Alternative A run to the absolute values of the Base Case run. The entries for 2008 (shown for control purposes) therefore need to be zero.

When interpreting the results in Table 1 it should be kept in mind that the orders of magnitude of the absolute numbers behind the differences in % are quite different. In 2008 the *Private Consumption Expenditure, Foreigners in Austria (Tourism)* were less than 10% of the *Private Consumption Expenditure, Austrians in Austria,* just to give one example.

Table 1 – Alternative A. Macro variables at constant prices 2005
Differences relative to the Base Case Scenario in %

	2008	2015	2030
Private consumption expenditure, Austrians in Austria	0,00	0,23	0,86
Private consumption expenditure, Foreigners in Austria (Tourism)	0,00	4,30	12,67
Final consumption expenditure by government	0,00	0,00	0,00
Final consumption expenditure by NPISH	0,00	0,00	0,00
Gross fixed capital formation	0,00	0,15	0,71
Exports (excl. Tourism)	0,00	0,00	0,00
Imports (excl. Tourism)	0,00	0,11	0,37
GDP	0,00	0,29	0,84
Employees (in full time equivalent)	0,00	0,21	0,56

[9] See Smeral (2010), chapter 5.2.3.2.

No differences can be seen for the results for *Final consumption expenditure by government, Final consumption expenditure by NPISH and Exports (excl. Tourism)*. According to the scenario design the hypotheses for these sets of exogenous variables are identical in all three scenarios.

The differences with respect to *Private consumption expenditure, Foreigners in Austria (Tourism)* are the direct result of the assumptions made.

Compared to the results of the Base Case Scenario private consumption of Austrian households is stimulated for all product groups distinguished. In cases in which consumption in real terms is going down this trend is less marked than in the Base Case.

The effects on domestic prices are very moderate for all product groups, the impacts on relative prices (vis a vis import prices) therefore are also low.

Employment is stimulated in all industries, although to a very different extent. In total a higher growth according Alternative A would create more than 19 000 additional jobs (in full term equivalents), about 8 000 of them in industry NACE 55 *Hotels and restaurants*.

Additional growth in a final demand category with a very specific composition by products necessarily leads to structural change in the economy. The direct effects stemming from additional tourists' expenditure on products such as *37| 55 Hotel and restaurant services* and all the transport services are amended by all the indirect effects via the production chain, induced by additional disposable income, by changes in prices, by additional capital formation, higher imports, etc.

A small part of this structural change induced by higher expenditures of foreign tourists is illustrated in Table 2 which is devoted to the effect on output by products. The range of differences in 2030 is quite remarkable.

As might be derived from Table 2 a number of product groups are affected considerably, which have no direct link to foreign tourists' expenditure. Examples for such product groups which are only affected very indirectly are among others:

19| 27 Basic metals
29| 37 Recovered secondary raw materials
51| 73 Research and development services

Table 2 – Alternative A. Output by products at constant prices 2005
Differences relative to the Base Case Scenario in %

No	CPA	2008	2015	2030
1|	01 Products of agriculture, hunting	0,00	0,34	0,92
2|	02 Products of forestry, logging	0,00	0,22	0,38
3|	05 Fish, other fishing products	0,00	0,48	1,58
4|	10 Coal and lignite, peat	0,00	0,00	0,00
5|	11 Crude petroleum, natural gas, metal ores (1)	0,00	0,00	0,00
6|	14 Other mining and quarrying products	0,00	0,22	0,64
7|	15 Food products and beverages	0,00	0,35	0,97
8|	16 Tobacco products	0,00	-0,05	-0,41

Table 2 – Alternative A Output by products at constant prices 2005 (continued)

No	CPA	2008	2015	2030
9	17 Textiles	0,00	0,20	0,40
10	18 Wearing apparel, furs	0,00	0,20	0,50
11	19 Leather and leather products	0,00	0,19	-0,07
12	20 Wood and products of wood	0,00	0,16	0,33
13	21 Pulp, paper and paper products	0,00	0,07	0,16
14	22 Printed matter and recorded media	0,00	0,05	0,31
15	23 Coke, refined petroleum products	0,00	0,25	0,70
16	24 Chemicals, chemical products	0,00	0,04	0,07
17	25 Rubber and plastic products	0,00	0,08	0,20
18	26 Other non-metallic mineral products	0,00	0,20	0,55
19	27 Basic metals	0,00	0,02	0,07
20	28 Fabricated metal products	0,00	0,08	0,25
21	29 Machinery and equipment n.e.c.	0,00	0,03	0,09
22	30 Office machinery and computers	0,00	0,02	0,22
23	31 Electrical machinery and apparatus	0,00	0,06	0,18
24	32 Radio, TV and communication equipment	0,00	0,08	0,20
25	33 Med., precision, opt. instruments, watches, clocks	0,00	0,02	0,12
26	34 Motor vehicles, trailers and semi-trailers	0,00	0,04	0,19
27	35 Other transport equipment	0,00	0,10	0,21
28	36 Furniture, other manufactured goods n.e.c.	0,00	0,13	0,40
29	37 Recovered secondary raw materials	0,00	0,05	0,15
30	40.1 Electricity	0,00	0,25	0,64
31	40.2 Gas, Steam and hot water	0,00	0,16	0,57
32	41 Water, distribution services of water	0,00	0,30	0,80
33	45 Construction work	0,00	0,29	0,97
34	50 Trade and repair services of motor vehicles etc.	0,00	0,07	0,63
35	51 Wholesale and comm. trade serv., ex. of motor vehicles	0,00	0,12	0,38
36	52 Retail trade serv., repair serv., exept of motor vehicles	0,00	0,18	0,74
37	55 Hotel and restaurant services	0,00	1,89	5,11
38	60 Land transport and transport via pipeline services	0,00	0,39	0,85
39	61 Water transport services	0,00	0,21	0,61
40	62 Air transport services	0,00	1,40	3,06
41	63 Supporting transport services, travel agency services	0,00	0,31	0,91
42	64 Post and telecommunication services	0,00	0,31	1,13
43	65 Financial intermediation services	0,00	0,16	0,44
44	66 Insurance and pension funding services	0,00	0,11	0,63
45	67 Services auxiliary to financial intermediation	0,00	0,12	0,54
46	70AM Real estate services - market	0,00	-0,11	-0,13
47	70AI Real estate services - owner occupied	0,00	0,65	1,47
48	70B Real estate agency services	0,00	0,00	0,17
49	71 Renting services of machinery and equipment	0,00	0,18	0,61
50	72 Computer and related services	0,00	0,06	0,34
51	73 Research and development services	0,00	0,02	0,07
52	74 Other business services	0,00	0,01	0,15
53	75 Public administration services etc.	0,00	0,00	0,01
54	80 Education services	0,00	0,02	0,07
55	85 Health and social work services	0,00	0,04	0,18
56	90 Sewage and refuse disposal services etc.	0,00	0,23	0,65
57	91 Membership organisation services n.e.c.	0,00	0,00	0,01
58	92 Recreational, cultural and sporting services	0,00	0,61	1,82
59	93 Other services	0,00	0,43	1,38
60	95 Private households with employed persons	0,00	0,25	0,79

Alternative B – Higher Growth

Assumptions

As already mentioned the two alternative Scenarios differ – compared to the Base Case Scenario – only with respect to the assumptions on total expenditures of foreign tourists in Austria, the structure of these expenditures and with respect to the input structure of industry NACE 55 *Hotels and restaurants*.

Alternative B is based on the high growth scenario (scenario 2) presented by Smeral (2010): An annual growth of 3% in real terms might be realized if Austria could become more attractive for tourists coming from countries with booming tourism expenditures of their residents. In this context countries like the new EU member countries, Brazil, China, Russia and India might play a much bigger role than in the past. In order to motivate more tourists from these countries to spend some time in Austria will however require a considerable reorientation of the Austrian tourism policy. There is a need for increasing the quality of tourism related services and the supply of new services[10].

For Alternative B the exogenous estimate of foreign tourists' expenditure had to be changed considerably. The starting points were again the product specific developments in real terms over the last 10 to 13 years. Most of the estimates of the Base Case Scenario had to be increased in order to arrive at the 3% growth of the Smeral study. As in the case of Alternative A even higher growth of expenditure was assumed for:

38| 60 Land transport and transport via pipeline services
40| 62 Air transport services
41| 63 Supporting transport services, travel agency services
42| 64 Post and telecommunication services
55| 85 Health and social work services
58| 92 Recreational, cultural and sporting services

These modifications were again introduced to take the trend towards more short term visits and towards trips because of health and wellness considerations and because of cultural events into due account.

The increase in nights spent in Austria (+2% per annum) according to the Smeral study was augmented by a quality factor.

Also in analogy to Alternative A very high product specific growth rates were only accepted for the period up to 2015. For the period 2016 to 2030 the standard levelling-out procedure was applied. The average growth rates for the entire period 2008 to 2030 are therefore the result of very high growth and strong structural change in the period up to 2015 and lower growth and reduced structural change for the rest of the period.

[10] See in particular Smeral (2010) p. 48.

The remarkable additional growth compared to the Base Case Scenario is associated with a higher utilization of existing capacities, primarily in hotels and restaurants and a marked increase in quality of the services. These two tendencies again had to be translated into changes in the input structure of industry NACE 55 *Hotels and restaurants*.

A move towards higher quality is seen as one of the conditions on which the high growth scenario of the SMERAL study rests. The changes introduced in the input structure of industry NACE 55 were much more pronounced than in the case of Alternative A but they refer to the same product groups as mentioned above.

In the Smeral study a higher qualification of the employees in tourism is seen as one of the necessary conditions for a better performance. Therefore it was assumed that the share of staff with a higher qualification will rise. This tendency will increase the wages and salaries per head independent of all other factors governing the development of labour income. As described above labour income is an endogenous variable in AEIOU II. In order to cover the effect of additional qualification an exogenous addition (a fix) on top of the labour income derived from the model was introduced.

Results

The structure of Table 3 is identical to the one of Table 1 and the entries can be interpreted in an analogous way. The Table again displays the main macro results relative to the Base Case Scenario.

Table 3 – Alternative B. Macro variables at constant prices 2005 Differences relative to the Base Case Scenario in %

	2008	2015	2030
Private consumption expenditure, Austrians in Austria	0,00	0,69	2,53
Private consumption expenditure, Foreigners in Austria (Tourism)	0,00	13,96	40,52
Final consumption expenditure by government	0,00	0,00	0,00
Final consumption expenditure by NPISH	0,00	0,00	0,00
Gross fixed capital formation	0,00	0,56	2,31
Exports (excl. Tourism)	0,00	0,00	0,00
Imports (excl. Tourism)	0,00	0,43	1,32
GDP	0,00	0,88	2,53
Employees (in full time equivalent)	0,00	0,65	1,62

It is worthwhile mentioning that the much higher annual growth rate assumed in Alternative B leads to a level of *Private consumption expenditure of foreigners in Austria* which is 40% higher than in the Base Case in 2030.

This considerable (positive) stimulus affects the endogenous *Private consumption expenditure of Austrians in Austria, Gross fixed capital formation* and *Imports* in a significant way. In 2030 GDP at 2005 prices would be 2,5% higher than in the Base Case.

Compared to the results of the Base Case Scenario private consumption is again stimulated for all product groups distinguished. The differences with respect to the Base Case are considerably bigger than in the case of Alternative A.

The effects on domestic prices are higher than in Alternative A but still quite limited for all product groups. As a consequence the impacts on relative prices and on the competitive position of Austria in the international competition are low.

Employment is stimulated in all industries, although again to a very different extent. In a number of branches the additional demand is to some extent compensated by a higher labour productivity than in the Base Case. In total a higher growth according Alternative B would create more than 55 000 additional jobs (in full term equivalents) in 2030.

The higher level of activities in all branches would be associated with higher compensation of employees per employee (in full time equivalents) in all industries. This additional increase in wages and salaries in all industries is in the order of magnitude of 1% to 3%.

As expected the effect of higher expenditures of foreign tourists on the structure of domestic production is more pronounced than in the case of Alternative A. Table 4 shows the deviations from the Base Case for Alternative B.

Table 4 – Alternative B. Output by products at constant prices 2005
Differences relative to the Base Case Scenario in %

No	CPA	2008	2015	2030
1	01 Products of agriculture, hunting	0,00	1,29	3,38
2	02 Products of forestry, logging	0,00	0,57	0,95
3	05 Fish, other fishing products	0,00	1,62	5,09
4	10 Coal and lignite, peat	0,00	0,00	0,00
5	11 Crude petroleum, natural gas, metal ores (1)	0,00	0,00	0,00
6	14 Other mining and quarrying products	0,00	0,62	1,82
7	15 Food products and beverages	0,00	1,28	3,50
8	16 Tobacco products	0,00	0,08	-0,41
9	17 Textiles	0,00	0,49	1,07
10	18 Wearing apparel, furs	0,00	0,50	1,39
11	19 Leather and leather products	0,00	0,31	-1,16
12	20 Wood and products of wood	0,00	0,46	0,97
13	21 Pulp, paper and paper products	0,00	0,28	0,58
14	22 Printed matter and recorded media	0,00	0,47	1,55
15	23 Coke, refined petroleum products	0,00	0,88	2,29
16	24 Chemicals, chemical products	0,00	0,14	0,23
17	25 Rubber and plastic products	0,00	0,27	0,65
18	26 Other non-metallic mineral products	0,00	0,58	1,60
19	27 Basic metals	0,00	0,07	0,23
20	28 Fabricated metal products	0,00	0,25	0,81
21	29 Machinery and equipment n.e.c.	0,00	0,12	0,33
22	30 Office machinery and computers	0,00	0,20	0,95

Table 4 – Alternative B. Output by products at constant prices 2005 (continued)

No	CPA	2008	2015	2030
23	31 Electrical machinery and apparatus	0,00	0,21	0,61
24	32 Radio, TV and communication equipment	0,00	0,29	0,67
25	33 Med., precision, opt. instruments, watches, clocks	0,00	0,12	0,46
26	34 Motor vehicles, trailers and semi-trailers	0,00	0,23	0,73
27	35 Other transport equipment	0,00	0,29	0,57
28	36 Furniture, other manufactured goods n.e.c.	0,00	0,44	1,29
29	37 Recovered secondary raw materials	0,00	0,16	0,47
30	40.1 Electricity	0,00	0,76	1,96
31	40.2 Gas, Steam and hot water	0,00	0,62	1,96
32	41 Water, distribution services of water	0,00	0,86	2,42
33	45 Construction work	0,00	0,85	2,83
34	50 Trade and repair services of motor vehicles etc.	0,00	0,89	2,99
35	51 Wholesale and comm. trade serv., ex. of motor vehicles	0,00	0,44	1,27
36	52 Retail trade serv., repair serv., exept of motor vehicles	0,00	0,70	2,53
37	55 Hotel and restaurant services	0,00	5,03	13,14
38	60 Land transport and transport via pipeline services	0,00	1,49	3,21
39	61 Water transport services	0,00	1,16	2,68
40	62 Air transport services	0,00	3,91	8,03
41	63 Supporting transport services, travel agency services	0,00	1,11	2,92
42	64 Post and telecommunication services	0,00	1,40	3,96
43	65 Financial intermediation services	0,00	0,51	1,40
44	66 Insurance and pension funding services	0,00	0,63	2,20
45	67 Services auxiliary to financial intermediation	0,00	0,56	1,84
46	70AM Real estate services - market	0,00	0,23	0,90
47	70AI Real estate services - owner occupied	0,00	1,00	2,68
48	70B Real estate agency services	0,00	0,39	1,35
49	71 Renting services of machinery and equipment	0,00	0,80	2,22
50	72 Computer and related services	0,00	0,27	1,19
51	73 Research and development services	0,00	0,10	0,24
52	74 Other business services	0,00	0,33	1,05
53	75 Public administration services etc.	0,00	0,01	0,02
54	80 Education services	0,00	0,07	0,25
55	85 Health and social work services	0,00	0,15	0,58
56	90 Sewage and refuse disposal services etc.	0,00	0,71	2,02
57	91 Membership organisation services n.e.c.	0,00	0,05	0,18
58	92 Recreational, cultural and sporting services	0,00	2,75	7,42
59	93 Other services	0,00	2,05	6,14
60	95 Private households with employed persons	0,00	0,68	2,30

Overview of results

Tables 1 to 4 provide some overview on the differences between the three scenarios. The following tables offer some comparisons of results expressed in growth rates.

Table 5 – Macro varables. Comparison of average annual growth rates (in %) at constant prices 2005; 2008 to 2030

	Base	Alt A	Alt B
Private consumption expenditure, Austrians in Austria	1,14	1,18	1,26
Private consumption expenditure, Foreigners in Austria (Tourism)	1,01	1,55	2,58
Final consumption expenditure by government	1,21	1,21	1,21
Final consumption expenditure by NPISH	0,87	0,87	0,87
Gross fixed capital formation	1,45	1,48	1,56
Exports (excl. Tourism)	2,71	2,71	2,71
Imports (excl. Tourism)	2,13	2,14	2,19
GDP	1,65	1,69	1,77
Employees (in full time equivalent)	0,37	0,40	0,45

At a first glance one might conclude that the differences presented in Table 5 are not very big. Because all the growth rates refer to a quite long period, the differences are however by no means negligible as shown in Tables 1 and 3.

The growth rates are much more dissimilar if the analysis is not done on the macro level but on the level of industries and product groups. The following tables provide some insight into the manifold effects.

The results displayed in Tables 6 are completely of indirect nature. The differences in *Private consumption expenditure, Austrians in Austria* result from the changes in the macro variable real disposable income of Austrian household and the differences in relative prices. Because the income elasticities and the price elasticities differ by products the outcome of the two Alternatives is quite distinct from the Base Case Scenario.

The differences in import demand as shown in Table 8 result from the differences in the activity levels of industries and thus from different needs for imported intermediate inputs. Import demand is also stimulated by imports for final demand purposes. Additional investment in vehicles for example will induce additional imports; additional private consumption will also stimulate the demand for products which are not produced domestically. The breakdown shown in Table 8 is by types of products not by receiving industries.

Table 6 – Output by products. Comparison of average annual growth rates (in %) at constant prices 2005; 2008 to 2030

No	CPA	Base	Alt A	Alt B
1	01 Products of agriculture, hunting	0,07	0,11	0,23
2	02 Products of forestry, logging	0,81	0,83	0,86
3	05 Fish, other fishing products	1,56	1,64	1,80
4	10 Coal and lignite, peat	0,00	0,00	0,00
5	11 Crude petroleum, natural gas, metal ores (1)	0,00	0,00	0,00
6	14 Other mining and quarrying products	0,91	0,94	0,99
7	15 Food products and beverages	1,16	1,21	1,33
8	16 Tobacco products	-11,84	-11,86	-11,86

Table 6 – Output by products (continued)

No	CPA	Base	Alt A	Alt B
9	17 Textiles	1,44	1,46	1,49
10	18 Wearing apparel, furs	-2,88	-2,86	-2,82
11	19 Leather and leather products	-2,48	-2,49	-2,53
12	20 Wood and products of wood	2,29	2,31	2,34
13	21 Pulp, paper and paper products	1,97	1,98	2,00
14	22 Printed matter and recorded media	1,15	1,16	1,22
15	23 Coke, refined petroleum products	-0,20	-0,17	-0,10
16	24 Chemicals, chemical products	1,95	1,96	1,96
17	25 Rubber and plastic products	1,82	1,83	1,85
18	26 Other non-metallic mineral products	1,78	1,80	1,85
19	27 Basic metals	0,96	0,97	0,98
20	28 Fabricated metal products	1,35	1,36	1,39
21	29 Machinery and equipment n.e.c.	1,33	1,34	1,35
22	30 Office machinery and computers	3,27	3,28	3,32
23	31 Electrical machinery and apparatus	1,34	1,34	1,36
24	32 Radio, TV and communication equipment	2,82	2,83	2,85
25	33 Med., precision, opt. instruments, watches, clocks	1,50	1,50	1,52
26	34 Motor vehicles, trailers and semi-trailers	1,36	1,37	1,40
27	35 Other transport equipment	2,55	2,56	2,57
28	36 Furniture, other manufactured goods n.e.c.	1,30	1,31	1,36
29	37 Recovered secondary raw materials	0,01	0,02	0,03
30	40.1 Electricity	1,05	1,08	1,14
31	40.2 Gas, Steam and hot water	0,37	0,39	0,46
32	41 Water, distribution services of water	2,19	2,23	2,30
33	45 Construction work	1,21	1,26	1,34
34	50 Trade and repair services of motor vehicles etc.	1,88	1,91	2,02
35	51 Wholesale and comm. trade serv., ex. of motor vehicles	2,08	2,09	2,14
36	52 Retail trade serv., repair serv., exept of motor vehicles	1,05	1,08	1,17
37	55 Hotel and restaurant services	1,33	1,57	1,98
38	60 Land transport and transport via pipeline services	2,53	2,57	2,69
39	61 Water transport services	1,68	1,70	1,80
40	62 Air transport services	2,91	3,05	3,30
41	63 Supporting transport services, travel agency services	1,96	2,00	2,09
42	64 Post and telecommunication services	2,69	2,75	2,88
43	65 Financial intermediation services	2,29	2,32	2,36
44	66 Insurance and pension funding services	3,21	3,24	3,31
45	67 Services auxiliary to financial intermediation	0,93	0,96	1,02
46	70AM Real estate services - market	1,55	1,54	1,59
47	70AI Real estate services - owner occupied	1,50	1,57	1,62
48	70B Real estate agency services	1,61	1,62	1,68
49	71 Renting services of machinery and equipment	1,40	1,43	1,51
50	72 Computer and related services	4,25	4,27	4,31
51	73 Research and development services	3,82	3,82	3,83
52	74 Other business services	2,17	2,18	2,22
53	75 Public administration services etc.	0,47	0,47	0,47
54	80 Education services	1,49	1,49	1,50
55	85 Health and social work services	1,70	1,71	1,73
56	90 Sewage and refuse disposal services etc.	2,30	2,33	2,40
57	91 Membership organisation services n.e.c.	0,82	0,82	0,83
58	92 Recreational, cultural and sporting services	1,35	1,43	1,70
59	93 Other services	1,32	1,39	1,62
60	95 Private households with employed persons	0,68	0,72	0,79

Table 7 – Private consumption expenditure, Austrians in Austria. Comparison of average annual growth rates (in %) at constant prices 2005; 2008 to 2030

No	CPA	Base	Alt A	Alt B
1	01 Products of agriculture, hunting	1,17	1,20	1,29
2	02 Products of forestry, logging	-0,34	-0,31	-0,24
3	05 Fish, other fishing products	-0,23	-0,22	-0,14
4	10 Coal and lignite, peat	-0,80	-0,79	-0,70
5	11 Crude petroleum, natural gas, metal ores (1)			
6	14 Other mining and quarrying products	0,70	0,74	0,81
7	15 Food products and beverages	0,92	0,96	1,03
8	16 Tobacco products	-1,55	-1,55	-1,55
9	17 Textiles	0,92	0,96	1,03
10	18 Wearing apparel, furs	1,05	1,09	1,16
11	19 Leather and leather products	1,24	1,27	1,35
12	20 Wood and products of wood	1,18	1,22	1,29
13	21 Pulp, paper and paper products	1,32	1,35	1,42
14	22 Printed matter and recorded media	1,52	1,52	1,63
15	23 Coke, refined petroleum products	0,50	0,53	0,61
16	24 Chemicals, chemical products	1,01	1,04	1,12
17	25 Rubber and plastic products	1,28	1,31	1,39
18	26 Other non-metallic mineral products	0,93	0,97	1,04
19	27 Basic metals	0,11	0,14	0,22
20	28 Fabricated metal products	1,16	1,19	1,27
21	29 Machinery and equipment n.e.c.	0,62	0,65	0,73
22	30 Office machinery and computers	-1,35	-1,32	-1,24
23	31 Electrical machinery and apparatus	1,33	1,37	1,44
24	32 Radio, TV and communication equipment	-0,36	-0,33	-0,25
25	33 Med., precision, opt. instruments, watches, clocks	1,00	1,04	1,11
26	34 Motor vehicles, trailers and semi-trailers	-0,54	-0,51	-0,44
27	35 Other transport equipment	0,62	0,65	0,73
28	36 Furniture, other manufactured goods n.e.c.	1,06	1,10	1,17
29	37 Recovered secondary raw materials			
30	40.1 Electricity	0,96	1,00	1,08
31	40.2 Gas, Steam and hot water	-0,08	-0,05	0,04
32	41 Water, distribution services of water			
33	45 Construction work	1,79	1,88	2,03
34	50 Trade and repair services of motor vehicles etc.	1,79	1,81	1,92
35	51 Wholesale and comm. trade serv., ex. of motor vehicles			
36	52 Retail trade serv., repair serv., exept of motor vehicles	1,24	1,26	1,32
37	55 Hotel and restaurant services	0,71	0,74	0,81
38	60 Land transport and transport via pipeline services	1,00	1,04	1,11
39	61 Water transport services	-0,29	-0,25	-0,18
40	62 Air transport services	-1,27	-1,16	-0,86
41	63 Supporting transport services, travel agency services	0,92	0,95	1,03
42	64 Post and telecommunication services	3,76	3,80	3,90
43	65 Financial intermediation services	1,36	1,40	1,47
44	66 Insurance and pension funding services	3,00	3,04	3,14
45	67 Services auxiliary to financial intermediation			
46	70AM Real estate services - market	0,95	0,98	1,03
47	70AI Real estate services - owner occupied	1,61	1,67	1,73
48	70B Real estate agency services	1,02	1,05	1,11
49	71 Renting services of machinery and equipment	0,23	0,25	0,33

Table 7 – Private consumption expenditure, Austrians in Austria (continued)

No CPA	Base	Alt A	Alt B
50 | 72 Computer and related services	4,37	4,38	4,43
51 | 73 Research and development services			
52 | 74 Other business services	1,14	1,16	1,23
53 | 75 Public administration services etc.	1,90	1,91	1,97
54 | 80 Education services	0,92	0,96	1,02
55 | 85 Health and social work services	1,56	1,58	1,65
56 | 90 Sewage and refuse disposal services etc.			
57 | 91 Membership organisation services n.e.c.	0,71	0,75	0,81
58 | 92 Recreational, cultural and sporting services	1,05	1,09	1,17
59 | 93 Other services	1,27	1,30	1,38
60 | 95 Private households with employed persons	0,72	0,75	0,82

Table 8 – Imports (excl. Tourism). Comparison of average annual growth rates (in %) at constant prices 2005; 2008 to 2030

No CPA	Base	Alt A	Alt B
1 | 01 Products of agriculture, hunting	3,67	3,72	3,83
2 | 02 Products of forestry, logging	2,42	2,44	2,48
3 | 05 Fish, other fishing products	0,01	0,08	0,26
4 | 10 Coal and lignite, peat	1,12	1,15	1,21
5 | 11 Crude petroleum, natural gas, metal ores (1)	1,55	1,57	1,62
6 | 14 Other mining and quarrying products	3,27	3,30	3,37
7 | 15 Food products and beverages	1,48	1,53	1,64
8 | 16 Tobacco products	-1,72	-1,74	-1,74
9 | 17 Textiles	1,28	1,30	1,35
10 | 18 Wearing apparel, furs	0,69	0,72	0,77
11 | 19 Leather and leather products	2,19	2,20	2,25
12 | 20 Wood and products of wood	2,51	2,52	2,56
13 | 21 Pulp, paper and paper products	2,64	2,64	2,67
14 | 22 Printed matter and recorded media	3,50	3,51	3,56
15 | 23 Coke, refined petroleum products	2,63	2,66	2,74
16 | 24 Chemicals, chemical products	2,50	2,51	2,53
17 | 25 Rubber and plastic products	2,59	2,60	2,63
18 | 26 Other non-metallic mineral products	2,12	2,14	2,20
19 | 27 Basic metals	1,21	1,22	1,23
20 | 28 Fabricated metal products	1,15	1,17	1,21
21 | 29 Machinery and equipment n.e.c.	1,42	1,44	1,47
22 | 30 Office machinery and computers	2,43	2,45	2,49
23 | 31 Electrical machinery and apparatus	2,12	2,13	2,15
24 | 32 Radio, TV and communication equipment	1,72	1,74	1,78
25 | 33 Med., precision, opt. instruments, watches, clocks	1,81	1,82	1,86
26 | 34 Motor vehicles, trailers and semi-trailers	-0,02	-0,01	0,03
27 | 35 Other transport equipment	7,99	8,00	8,02
28 | 36 Furniture, other manufactured goods n.e.c.	1,52	1,54	1,58
29 | 37 Recovered secondary raw materials	1,20	1,21	1,22
30 | 40.1 Electricity	4,14	4,16	4,22
31 | 40.2 Gas, Steam and hot water	0,37	0,39	0,46
32 | 41 Water, distribution services of water	0,68	0,69	0,70
33 | 45 Construction work	1,29	1,34	1,43

Table 8 – Imports (excl. Tourism) (continued)

No	CPA	Base	Alt A	Alt B
34	50 Trade and repair services of motor vehicles etc.	2,16	2,20	2,31
35	51 Wholesale and comm. trade serv., ex. of motor vehicles	1,83	1,85	1,89
36	52 Retail trade serv., repair serv., exept of motor vehicles	1,05	1,08	1,17
37	55 Hotel and restaurant services	1,92	1,96	2,06
38	60 Land transport and transport via pipeline services	3,30	3,31	3,34
39	61 Water transport services	3,00	3,01	3,03
40	62 Air transport services	2,86	2,88	2,93
41	63 Supporting transport services, travel agency services	2,81	2,86	2,97
42	64 Post and telecommunication services	2,75	2,79	2,92
43	65 Financial intermediation services	2,01	2,03	2,09
44	66 Insurance and pension funding services	3,09	3,12	3,20
45	67 Services auxiliary to financial intermediation	2,04	2,06	2,12
46	70AM Real estate services - market	1,98	1,97	2,01
47	70AI Real estate services - owner occupied			
48	70B Real estate agency services	1,59	1,59	1,64
49	71 Renting services of machinery and equipment	1,92	1,97	2,08
50	72 Computer and related services	4,56	4,58	4,63
51	73 Research and development services	2,16	2,17	2,19
52	74 Other business services	1,98	1,99	2,04
53	75 Public administration services etc.	0,47	0,47	0,47
54	80 Education services	1,13	1,14	1,17
55	85 Health and social work services	1,60	1,64	1,72
56	90 Sewage and refuse disposal services etc.	1,81	1,84	1,91
57	91 Membership organisation services n.e.c.	0,82	0,82	0,83
58	92 Recreational, cultural and sporting services	1,06	1,10	1,23
59	93 Other services	1,29	1,35	1,54
60	95 Private households with employed persons			

Standard approaches of assessing the impact of an increase in tourists’ expenditure

Tourists’ expenditure seen in an isolated way

In many studies which are devoted to the role of tourism[11] the change in a final demand category is analysed in an isolated way. The increase is demand is only seen in relation to the immediate effect on domestic production. In the case of additional expenditure of foreign tourists only the part of demand which is directly met by imports needs to be subtracted. The remaining “domestic part” of the additional demand can then be set in relation to total domestic production of the various products groups.

[11] The special issue of Economic Systems Research 4/2010 edited by Bart Los and Albert Steenge with the title ”Tourism Studies and Input-Output Analysis” provides an overview of literature of studies dealing with the role of tourism which use to a certain extent input-output techniques.

Table 9 shows the direct effect on domestic production for the two scenarios described above relative to the Base Case Scenario. Table 9 can also be interpreted as the numerical documentation of the exogenous assumptions for the model runs with AEIOU II for the year 2030.

In this simple analysis the domestic production of the base year is taken as the reference solution and set equal to the Base Case Scenario. The results therefore report the additional domestic production in base year 2005 if the expenditures of foreign tourists 2005 are replaced by the expenditures of foreign tourists 2030 under the assumptions of Scenario A (or Scenario B). All calculations are carried out at prices 2005.

As might be seen from Table 9 in the Scenarios the effect of additional tourists' expenditure is not limited to additional demand for services from hotels and restaurants although the share of this additional demand is very high. It is nearly 70% of the additional demand in Scenario A and more than 60% in the case of Scenario B. Shares of more than 4% in both Scenarios are also given for CPA 60 *Land transport and transport via pipeline services*, CPA 62 *Air transport services*, CPA 64 *Post and telecommunication services* and CPA 92 *Recreational, cultural and sporting services*.

The share of the demand of non-resident private households for domestic products in total domestic supply differs considerably by products, also for the products with a special relevance for tourists. The share amounts to almost 30% for CPA 55 *Hotel and restaurant services* and more than 20% for CPA 62 *Air transport services.* On the other hand the shares for CPA 60 *Land transport and transport via pipeline services* (8,5%), CPA 92 *Recreational, cultural and sporting services* (8,1%) and CPA 93 *Other services* (11,5%) are lower. For CPA 23 *Coke, refined petroleum products* the share is only 3%.

As a consequence the relative importance of additional demand of non-resident households on production of these products also differs considerably. The dominating relevance of tourists' expenditure for CPA 55 *Hotel and restaurant services,* CPA 92 *Recreational, cultural and sporting services* and of traffic related services such as in particular CPA 62 *Air transport services* remains is obvious.

Table 9 – Direct effects on domestic production 2030
Differences relative to the Base Case Scenario in % (at 2005 prices)

No	CPA	Alt A	Alt B
1	01 Products of agriculture, hunting	0,00	0,00
2	02 Products of forestry, logging	0,00	0,00
3	05 Fish, other fishing products	0,05	0,21
4	10 Coal and lignite, peat	-0,02	-0,02
5	11 Crude petroleum, natural gas, metal ores (1)	0,00	0,00
6	14 Other mining and quarrying products	0,00	0,00
7	15 Food products and beverages	0,00	0,09
8	16 Tobacco products	-0,08	-0,08
9	17 Textiles	0,00	0,00
10	18 Wearing apparel, furs	0,00	0,00

Table 9 – Direct effects on domestic production 2030 (continued)

No	CPA	Alt A	Alt B
11	19 Leather and leather products	0,00	0,03
12	20 Wood and products of wood	0,00	0,00
13	21 Pulp, paper and paper products	0,00	0,01
14	22 Printed matter and recorded media	0,00	0,00
15	23 Coke, refined petroleum products	0,00	0,14
16	24 Chemicals, chemical products	0,00	0,01
17	25 Rubber and plastic products	0,00	0,00
18	26 Other non-metallic mineral products	0,00	0,00
19	27 Basic metals	0,00	0,00
20	28 Fabricated metal products	0,00	0,00
21	29 Machinery and equipment n.e.c.	0,00	0,00
22	30 Office machinery and computers	0,00	0,01
23	31 Electrical machinery and apparatus	0,00	0,00
24	32 Radio, TV and communication equipment	0,00	0,01
25	33 Med., precision, opt. instruments, watches, clocks	0,00	0,03
26	34 Motor vehicles, trailers and semi-trailers	0,00	0,00
27	35 Other transport equipment	0,00	0,00
28	36 Furniture, other manufactured goods n.e.c.	0,01	0,08
29	37 Recovered secondary raw materials	0,00	0,00
30	40.1 Electricity	0,00	0,01
31	40.2 Gas, Steam and hot water	0,00	0,03
32	41 Water, distribution services of water	0,00	0,00
33	45 Construction work	0,00	0,01
34	50 Trade and repair services of motor vehicles etc.	0,21	1,21
35	51 Wholesale and comm. trade serv., ex. of motor vehicles	0,00	0,05
36	52 Retail trade serv., repair serv., exept of motor vehicles	0,01	0,22
37	55 Hotel and restaurant services	7,21	20,17
38	60 Land transport and transport via pipeline services	0,93	3,93
39	61 Water transport services	0,59	3,31
40	62 Air transport services	5,15	13,71
41	63 Supporting transport services, travel agency services	0,34	1,25
42	64 Post and telecommunication services	0,72	2,68
43	65 Financial intermediation services	0,00	0,00
44	66 Insurance and pension funding services	0,00	0,01
45	67 Services auxiliary to financial intermediation	0,00	0,00
46	70AM Real estate services - market	0,06	0,35
47	70AI Real estate services - owner occupied	0,00	0,00
48	70B Real estate agency services	0,01	0,03
49	71 Renting services of machinery and equipment	0,06	0,33
50	72 Computer and related services	0,00	0,00
51	73 Research and development services	0,00	0,00
52	74 Other business services	0,00	0,00
53	75 Public administration services etc.	0,00	0,00
54	80 Education services	0,01	0,04
55	85 Health and social work services	0,08	0,23
56	90 Sewage and refuse disposal services etc.	0,00	0,00
57	91 Membership organisation services n.e.c.	0,00	0,00
58	92 Recreational, cultural and sporting services	1,73	8,05
59	93 Other services	0,57	3,81
60	95 Private households with employed persons	0,00	0,05
	Total	0,39	1,24

Taking the production effects of tourists' expenditure into account

In the absence of a dynamic multisectoral model it is quite usual to calculate at least the direct production effects of changes in one of the final demand categories with the help of the static open Leontief model.

The additional domestic production induced by a higher tourists' demand in Scenario A compared to the situation in the Base Case is then calculated simply by:

$$X^{\text{Scenario A}} = (I - B)^{-1} . (FDD^{\text{Scenario A}} - FDD^{\text{Base Case}})$$

$X^{\text{Scenario A}}$ stands for the additional production induced by the additional final demand according to Scenario A compared to the Base Case Scenario

$FDD^{\text{Scenario A}}$ stands for final demand (domestic deliveries only) under the assumption of additional demand of foreign tourists 2030; "what final demand would have been, if the expenditures of foreign tourists 2005 are replaced by the expenditures of foreign tourists 2030 under the assumptions of Scenario A".

$FDD^{\text{Base Case}}$ stands for final demand (domestic deliveries only) under the assumption of additional demand of foreign tourists 2030; "what final demand would have been, if the expenditures of foreign tourists 2005 are replaced by the expenditures of foreign tourists 2030 under the assumptions of the Base Case Scenario".

B stands for the product by product matrix of input coefficients (domestic deliveries only) of the base year (2005)

The additional domestic production induced by a higher tourists' demand in Scenario B compared to the situation in the Base Case can be calculated in an analogous way by replacing $FDD^{\text{Scenario A}}$ by $FDD^{\text{Scenario B}}$.

In this type of computations all the other final demand categories are kept constant. There is no effect from the additional production on income and thus on consumption and capital formation. There is also no effect on prices and on the competiveness of the economy. The matrix of input coefficients (domestic deliveries only) is not only based on the technology of the base year 2005 but also on the import shares of the base year 2005. Again all calculations are at prices of the base year 2005.

As might be seen from Table 10 the effects are much higher than in the case of Table 9. The total effect on domestic production is 0,62% compared to 0,39% for Scenario A and 1,95% compared to 1,24% for Scenario B.

Even much more pronounced are the differences in the results with respect to the production patterns. As expected the big direct effect on the production of *Hotel and restaurant services* causes remarkable indirect effects on the productions of products like CPA 01 *Products of agriculture, hunting* and CPA 15 *Food products and beverages.* The high effects on all the energy related products such as CPA 40.1 *Electricity*, CPA 40.2 *Gas, Steam and hot water* but also on CPA 23 *Coke, refined petroleum products* is almost entirely of indirect nature and caused both by the additional direct demand for *Hotel and restaurant services* and for the traffic related services.

On the first glance it seems surprising that the results for the Scenario A relative to the Base Case Scenario as derived with the help of AEIOU II as shown in the third column of Table 2 are generally speaking only a little bit higher than the ones shown in Table 10, although in AEIOU II all the income effects etc. are taken into account. A comparison of the third column of Table 6 for Scenario B with the second column of Table 10 leads to similar findings. The production effects for most products is higher when then results of AEIOU II are analysed, but there are also some products for which the simple calculation with the open static Leontief model leads to higher production effects.

Table 10 – Effects on domestic production 2030 taking the production chain into account Differences relative to the Base Case Scenario in % (at 2005 prices)

No	CPA	Alt A	Alt B
1	01 Products of agriculture, hunting	0,87	2,51
2	02 Products of forestry, logging	0,04	0,14
3	05 Fish, other fishing products	2,50	7,09
4	10 Coal and lignite, peat	0,74	2,51
5	11 Crude petroleum, natural gas, metal ores (1)	0,14	0,49
6	14 Other mining and quarrying products	0,17	0,53
7	15 Food products and beverages	0,86	2,51
8	16 Tobacco products	-0,08	-0,08
9	17 Textiles	0,11	0,36
10	18 Wearing apparel, furs	0,02	0,09
11	19 Leather and leather products	0,01	0,05
12	20 Wood and products of wood	0,05	0,18
13	21 Pulp, paper and paper products	0,10	0,34
14	22 Printed matter and recorded media	0,30	1,00
15	23 Coke, refined petroleum products	0,33	1,15
16	24 Chemicals, chemical products	0,08	0,26
17	25 Rubber and plastic products	0,10	0,35
18	26 Other non-metallic mineral products	0,13	0,43
19	27 Basic metals	0,03	0,09
20	28 Fabricated metal products	0,10	0,33
21	29 Machinery and equipment n.e.c.	0,05	0,16
22	30 Office machinery and computers	0,02	0,09
23	31 Electrical machinery and apparatus	0,07	0,24
24	32 Radio, TV and communication equipment	0,06	0,24
25	33 Med., precision, opt. instruments, watches, clocks	0,04	0,16
26	34 Motor vehicles, trailers and semi-trailers	0,01	0,03
27	35 Other transport equipment	0,23	0,72
28	36 Furniture, other manufactured goods n.e.c.	0,05	0,23

Table 10 – Effects on domestic production 2030 taking the production chain into account (continued)

No	CPA	Alt A	Alt B
29	37 Recovered secondary raw materials	0,05	0,17
30	40.1 Electricity	0,41	1,34
31	40.2 Gas, Steam and hot water	0,25	0,86
32	41 Water, distribution services of water	0,76	2,38
33	45 Construction work	0,19	0,61
34	50 Trade and repair services of motor vehicles etc.	0,35	1,73
35	51 Wholesale and comm. trade serv., ex. of motor vehicles	0,23	0,73
36	52 Retail trade serv., repair serv., exept of motor vehicles	0,12	0,55
37	55 Hotel and restaurant services	7,32	20,50
38	60 Land transport and transport via pipeline services	1,15	4,72
39	61 Water transport services	0,74	3,79
40	62 Air transport services	5,88	15,79
41	63 Supporting transport services, travel agency services	0,98	3,23
42	64 Post and telecommunication services	1,17	4,26
43	65 Financial intermediation services	0,33	1,07
44	66 Insurance and pension funding services	0,17	0,56
45	67 Services auxiliary to financial intermediation	0,23	0,74
46	70AM Real estate services - market	0,62	2,09
47	70AI Real estate services - owner occupied	0,00	0,00
48	70B Real estate agency services	0,49	1,68
49	71 Renting services of machinery and equipment	0,53	1,96
50	72 Computer and related services	0,08	0,27
51	73 Research and development services	0,07	0,25
52	74 Other business services	0,42	1,41
53	75 Public administration services etc.	0,00	0,01
54	80 Education services	0,02	0,08
55	85 Health and social work services	0,09	0,25
56	90 Sewage and refuse disposal services etc.	0,59	1,86
57	91 Membership organisation services n.e.c.	0,05	0,17
58	92 Recreational, cultural and sporting services	1,94	8,92
59	93 Other services	0,81	4,52
60	95 Private households with employed persons	0,00	0,05
	Total	0,62	1,95

On the global level the analysis with the help of AEIOU II reports a total level of production that is 0,67% higher than in the Base Case for Scenario A, compared to a 0,62% higher total production in the case of calculations with the open static Leontief model. For Scenario B the differences are 2,2% (AEIOU II) and 1,9% (static open Leontief model) respectively. A non-expert observer might therefore conclude that relatively little can be gained by the development of such a complex model as AEIOU II.

Such a comparison is not only misleading, it is not legitimate:

- In the simulations with AEIOU II the increase in foreign tourism affects the other major categories of final demand such as private consumer expenditure of resident households and capital formation via the income and production effects but also because of implications on prices; in the simple calculations described above the other categories of final demand remain unchanged if foreign tourism is altered.

- In the simulations with AEIOU II the increase in foreign tourism affects prices and via prices the competitive position of Austria. In particular price changes affect imports. In the simple calculations no such feedback effects are taken into account.
- The simulations with AEIOU II for 2030 are based on an import matrix for 2030 which shows considerable higher import shares than in 2005, the matrix on which the simple calculations are based.

The simple standard approaches only provide ceteris paribus analyses of the type "what would have been, if". In the simulations with AEIOU II the analysis is carried out in a dynamic setting taking the major feedback effects into account. The results relate to different situations in 2030; in addition the time-path leading to the final situations in 2030 are shown.

Simulations with the help of a model like AEIOU II cover all the direct effects and all the production effects. In addition they offer insight in all the macro implications and detailed results for the effects on employment, wages and salaries, domestic prices, etc.

Concluding remarks

Taking a study published by the Austrian Institute for Economic Research as background the implications of two alternative growth paths for foreign tourists' expenditure were analyzed. The exercise showed very positive effects of additional growth in tourism on all relevant variables of the Austrian economy.

The exercise for the period 2008 to 2030 also made it very clear that it is not sufficient to limit the analysis to the effects on the macro level. The implications on the level of industries and products groups are much more marked and deserve special attention. The range of differences by industries and/or product groups is quite remarkable.

The investigation underlined that in order to study the manifold effects induced by a final demand category with a very specific product structure a disaggregated approach is indispensable. The high degree of division of labour within an economy like Austria asks for an input-output approach to trace the indirect production related effects on nearly all branches in the economy.

The problem under consideration also requires an instrument which has all the properties of a well developed macro model as regards the effects on income, capital formation, imports and prices. As the few results presented in the Tables above show, the indirect effects via changes in income, in activity level etc. affect all the major variables considerably.

Last but not least the exercise proofed that the model AEIOU II is ready for carrying out such simulations in a meaningful way.

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Foreign Trade Changes and Sectoral Development: Comparison of the Baltic Countries

Introduction

For a country with exports as a driving force, the ability of exporters to deal with difficulties successfully is crucial. It involves abilities to retain existing and find new markets for their productions, as well as modification of products suitable to fulfill the desires of consumers, which is observable as a change in export structure. On the other hand, also structural analysis of import is significant to reveal, how a country ensures national economic development in global growth conditions.

Vast number of studies is devoted to the analysis of export and import in relation to economic crisis. For example, Levchenko, Lewis and Tesar (2010) analyze U.S. export and import data disaggregated at the 6-digit NAICS level and find that sectors used as intermediate inputs experienced significantly higher percentage reductions in both imports and exports. Chor and Manova (2010) analyze export and import in connection with credit conditions. In Latvia export is analyzed mainly from the point of view of its competitiveness and quality. For example, Beņkovskis and Rimgailaite (2010) analyze detailed data on exports in order to evaluate its quality and variety, Beņkovskis (2012) analyzes competitiveness of Latvia's exporters.

The aim of the paper is to reveal structural changes in foreign trade of Latvia, in comparison with Lithuania and Estonia and as well as to obtain detailed and disaggregated information for modeling. Comparison of foreign trade structure and other indicators of the Baltic countries also provide information on how similar are these countries and whether it is useful

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to use data of Estonia and Lithuania to fill some data gaps regarding the Latvian economy.

The structure of the paper is as follows: methodology (of analysis of foreign trade statistics and input-output data) and analysis and results. In the paper, the time period of 2000-2011 is analyzed.

The major databases used in the research are Eurostat data base (including National Accounts, Input-Output data, Comtrade etc.) and the databases of national statistical bureaus (for instance, Latvia's national statistical bureau (CSB)). Sectoral codes are given in Appendix 1 and 2.

Methodology

A. Analysis of Foreign Trade Statistics

Since 2000, it is possible to distinguish several periods of different patterns of economic development in all three Baltic countries – moderate economic growth, sharp economic growth, deep recession and growth again. Therefore as important reference years for foreign trade analysis, 2000 (the base year), 2004 (the EU enlargement), 2007 for Latvia and Estonia and 2008 for Lithuania (peak of GDP), 2009 (largest economic decline (recession) in all three countries) and 2011 (revived growth above 5%) were chosen. It is worth to outline that two of selected reference years (2004, 2007) are being analyzed in more detail using input-output tables in the second part of the research.

Export and import of goods is analyzed according to classification by Broad Economic Categories (BEC Rev. 4), Combined Nomenclature and by industries of NACE classification (Rev. 1.1).

There are many studies, which focus on different problems of export-oriented industries in different countries, for example, Nanda and Khanna (2010) study cross-border social networks and their influence on Indian software industry, Ge (2008) analyzes issues of globalization and industry agglomeration in China, Pepper (2012) focuses on feminization of labour and socio-economic effects of this process in the Global South; however, they rarely define criteria, which distinct export-oriented industries from the rest. Borensztein and Panizza (2010) use the principle that export-oriented industries are in the 75th percentile of the distribution of export-orientation index, which is calculated as the average ratio of export over output, and less export-oriented – in the 25th percentile of the distribution. Other studies analyze export orientation data, showing trends and relations without clear distinction between export-oriented and other industries. Moreover, Campa and Goldberg (1997) analyze export shares together with import shares of inputs, obtaining net external orientation. To show the importance of export and import by industries in Latvia, two indicators are used:

export orientation ratio and import share. Both indicators are calculated, using variables in current prices.

Export orientation ratio is calculated using a formula:

$$rexp_i = \frac{exp_i}{x_i} \tag{1}$$

Where $rexp_i$ – export orientation ratio in industry i;
exp_i – export of goods in industry i;
x_i – gross output of industry i.

Import share is calculated using a formula:

$$impsh_i = \frac{imp_i}{imp_i + x_i} \tag{2}$$

Where $impsh_i$ – import share in industry i;
imp_i – import of goods in industry i;
x_i – gross output of industry i.

The authors are aware that export and import of services should not be omitted to assess the importance of export and import activities, however, in this study industries, which are involved primarily in export and import of goods, are analyzed in more detail, that is agriculture (A01 and A02), fishing (B), mining and quarrying (C10-14) and manufacturing (D15-37).

B. Analysis of Input-output tables

In the study that involved the analysis of input-output data (of Latvia, Lithuania and Estonia), seven indicators are computed on the basis of NA and IO table data and analysed: ratio of export to total use (by branches), gross labour productivity, ratio of efficiency of unit spent for labour, value added per employed person, ratio of value added to compensation of employees, ratio of value added to wages and salaries, and labour input coefficient.

Ratio of export to total use by branches ($dexp_i$) is computed by the following formula:

$$dexp_i = \frac{exp_i}{use\_dom_i + exp_i} \tag{3}$$

Where exp_i – export of goods in branch i;
use_dom_i – total domestic use of branch i;

The ratio $dexp_i$ indicates the importance of export in the economy. Nowadays, many experts and policy makers believe that the higher the export orientation ($rexp_i$) the better; however quite frequently in small-open economies (as the Baltic countries) the higher export orientation drives demand and use of imported products in order to ensure additional production output. Hence, the ratio of export to total use by branches is more adequate for detailed analysis.

Growing export volume indicates the competitiveness of producers in global market, however, it depends on productivity, hence a set of productivity representing indicators are applied.

Indicator of gross labour productivity by branch is computed by the following formula:

$$p_i = \frac{x_i}{e_i} \quad (4)$$

Where p_i – gross labour productivity of sector i;

x_i – gross output of branch i;

e_i – number of employed persons in branch i.

The authors admit that this solution is a trade-off of theoretical and data endowment. For instance, Belegri-Roboli et.al (2011) analysing the labour productivity and working time changes in Greece use employment measured in hours worked. But this approach (hours worked) neither employment measured in full-time equivalents are not applicable in this case due to lack of data in appropriate level of disaggregation and length of time-series.

Ratio of productivity of unit spent on labour (gross output per unit spent on labour) p_u_i is computed by the following formula:

$$p\_u_i = \frac{x_i}{c_i} \quad (5)$$

Where c_i – compensation of employees in branch i;

This indicator shows how many units of output (in money terms) are generated by one unit spent on labour.

Value added per employed person is computed by the following formula:

$$pv_i = \frac{va_i}{e_i} \quad (6)$$

According to the general confidence, the higher the valued added by employee, the better for the economy.

Ratio of value added to compensation of employees pv_u_i is computed by the following formula:

$$pv\_u_i = \frac{va_i}{c_i} \quad (7)$$

Ratio of value added to compensation of employees is important indicator that embodies the ability of one unit spent on labour to generate one unit of value added. As value added and consequently gross domestic product are major economic outcome estimation indicators, the higher value of this ratio indicated higher potential to generate larger value added. In general, the larger the value added in the economy in general and per capita, the better. Consequnetly, the higher value of this ratio, the better for the economy.

In order to reveal the economic effect of labour to generate value added, the modified ratio – the ratio of value added to wages and salaries $pv^*\_u_i$ - is computed by the following formula:

$$pv\_u_i^* = \frac{va_i}{w_i} \qquad (8)$$

Labour input coefficient l_i of branch i is computed by the following formula:

$$l_i = \frac{c_i}{x_i} \qquad (9)$$

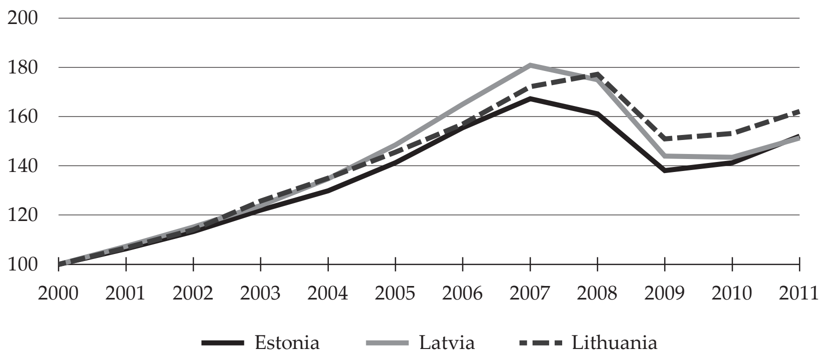
Economic activity is analysed according to level of sectoral disaggregation of NACE classification Rev. 1.1 regarding major (1-digit disaggregation) and more sophisticated sectoral disaggregation (3-digit disaggregation). Results of computation in sectoral level are compared with Estonia's and Lithuania's sectoral results, as well dynamics are analysed.

Analysis and Results

A. Economic Growth and Foreign Trade Statistics

Notable changes in economic development both local and global force the companies to change their activities, especially in small open economies like the Baltic countries – Latvia, Lithuania and Estonia. Fig. 1 shows that the enlargement of the European Union in 2004 helped to boost the real GDP growth in all the three Baltic countries, especially in Latvia with a peek in 2007 (for Lithuania in 2008). However, afterwards all three countries faced a serious recession, which began in 2008 in Latvia and Estonia, and continued in 2009 (for Latvia, also in 2010, when Lithuania and Estonia experienced a little improvement). As a result GDP volume fell to lower than that of 2006 in Lithuania and of 2005 in Latvia and Estonia. However, in 2011 economic growth exceeded 5% in all three countries.

Figure 1 – Real GDP Indexes in the Baltic countries (2000 = 100), %



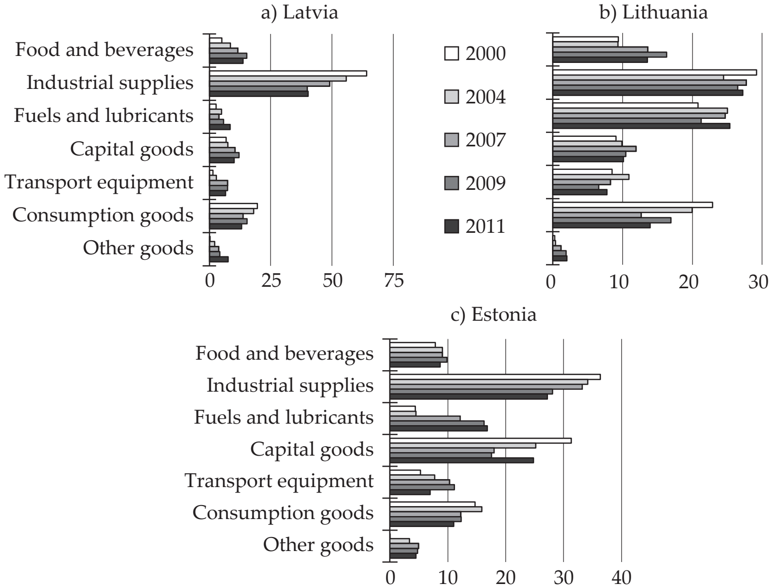
Source: Eurostat Database.

Analysis of export structure by Broad Economic Categories shows that the largest group of exported goods in Latvia is industrial supplies. The share of industrial supplies has decreased from 64.1% in 2000 to 39.9% in 2009, afterwards being more or less stable (see Fig.2 a). In other groups major changes are mainly evident in 2000-2007 or even in 2004-2007. Only the share of fuels and lubricants and other goods is increasing notably also in 2007-2011.

Export structure of goods in Lithuania and Estonia is more diversified, as it is presented in Fig. 2 b and c respectively. In Latvian case industrial supplies form one significant product group followed by three other product groups, which exceeded 10% in 2007-2011. Industrial supplies are the most important export goods also in Lithuania and Estonia. However, in Lithuania also fuels and lubricants are very important followed by three other groups exceeding 10% of export of goods, and in Estonia also capital goods are significant, followed by fuels and lubricants and consumption groups.

Notable changes in Lithuania have occurred in all reference years at least in two product groups, the share of consumption goods has varied the most. It is interesting to note that export structure in Lithuania in 2008 is almost the same as in 2011. However, in Estonia the share of capital goods faced significant drop in 2000-2007, while significant increase in export of fuels and lubricants occurred after 2004. The share of only two export groups significantly changed in 2007-2009 and the share of other two in 2009-2011.

Figure 2 – Structure of Export of Goods by Broad Economic Categories, %

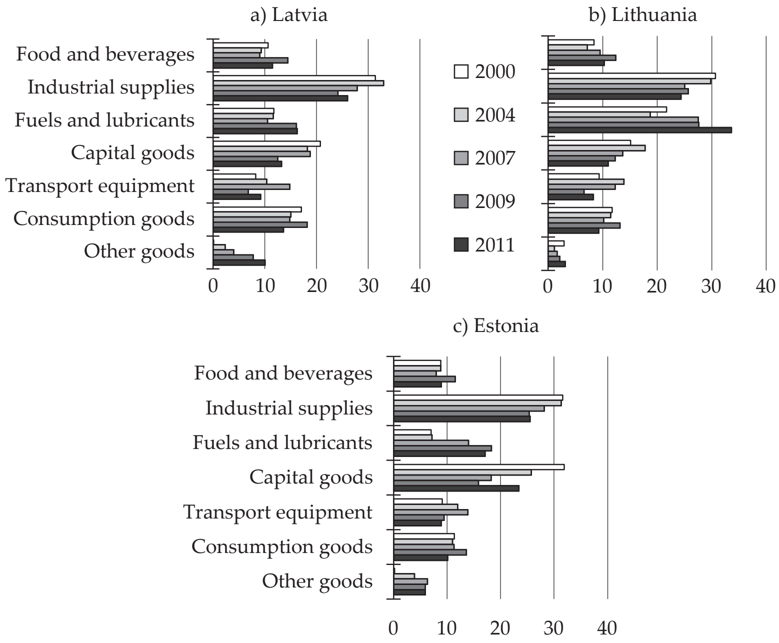


Source: Authors' calculation based on Comtrade Database.

Export structure in three Baltic countries are different, therefore also structural changes differ. Nevertheless, in all countries the years of faster development brought by the most significant changes in export structure and the EU enlargement was a significant driver of change. Notable changes can be observed also during recession. However, the revived growth did not have much influence on export structure in Latvia, while there were significant changes in Lithuania and Estonia.

Industrial supplies are also the main group of goods in import in all three countries (see Fig. 3), however, in Latvia, its share is significantly smaller, comparing with the export structure. In Latvia major changes in import structure are associated with 2007-2009, the years with the highest and lowest GDP growth rates. Only the share of transport equipment has significantly increased in 2000-2007. The shares of food and beverages, fuels and lubricants and other goods have increased more notably in 2007-2009, but the biggest declines are associated with capital goods and transport equipment. Enterprises were struggling to maintain in operation, therefore possibilities to renew equipment were scarce, while the decline in transport equipment is more related with decrease in private consumption.

Figure 3 – Structure of Import of Goods by Broad Economic Categories, %



Source: Authors' calculation based on Comtrade Database.

In Lithuania and Estonia import structure (Fig. 3 b and c) is similar to export structure. The most significant changes are evident in 2004-2008 and in some cases also in 2009-2011.

If export structure is analysed by product groups, it is observable that till 2007, wood and wood products were the leading commodity section in exports of Latvia (see Fig. 4 a), but sophistication of manufacturing together with the increased foreign demand facilitated the growth in other sectors, too (the development of industry involves purchase and application of new (latest) technologies and modern machinery (partly financed by the structural funds of the European Union) that, in result, stimulates the export of higher value added goods). As a result export structure is now more diverse. The most notable changes were during 2000-2007, especially regarding wood and wood products, textiles and textile articles (negative direction) and food and agricultural products, machinery and electrical equipment and transport vehicles (positive direction). However, also in 2007-2009 significant changes are evident in several groups of products.

In comparison, in 2011 in Lithuania mineral products and food and agricultural products were leading, but in Estonia – machinery and electrical equipment and mineral products (see Fig. 4 b and c).

Figure 4 – Structure of Export of Goods by Principal Commodity Sections, %

a) Latvia

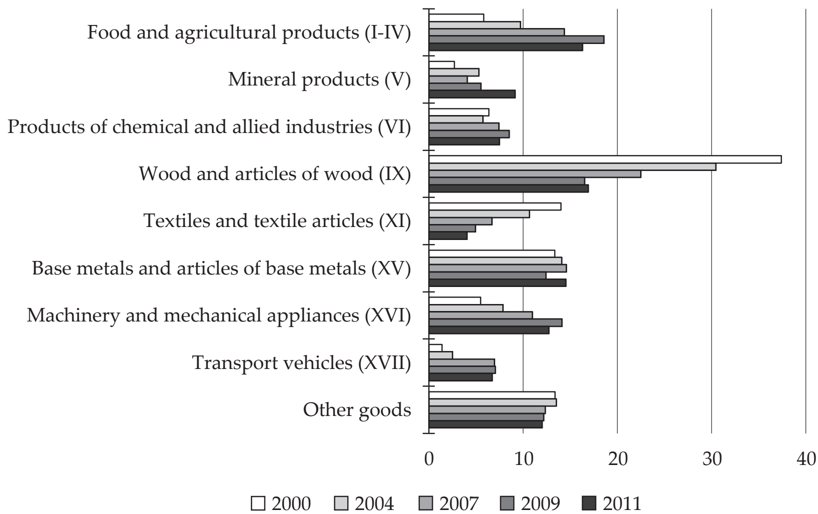
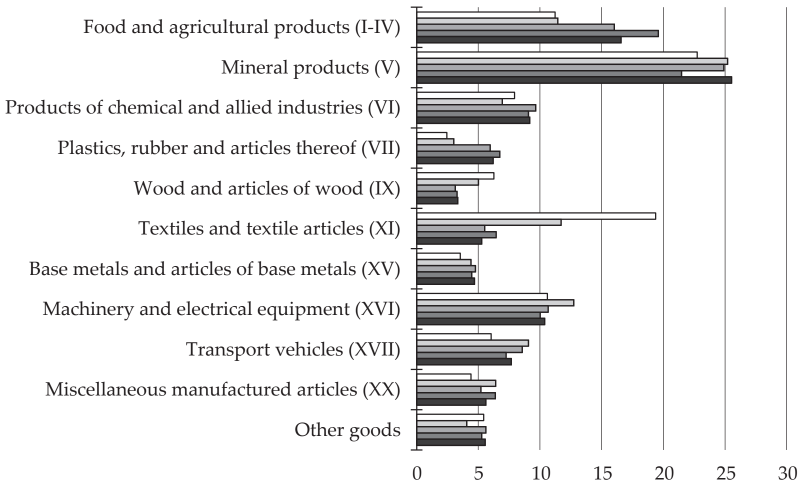
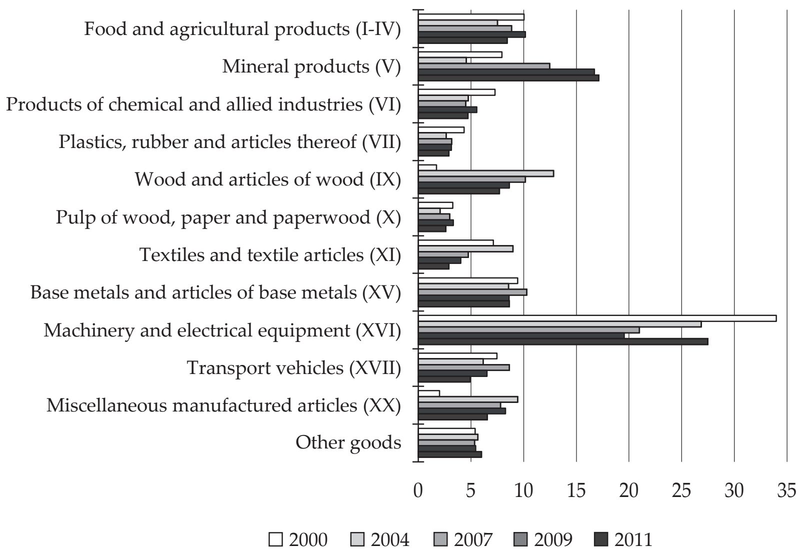


Figure 4 – Structure of Export of Goods by Principal Commodity Sections, % (continued)

b) Lithuania



c) Estonia



Source: Authors' calculation based on CSB Database, Statistics Lithuania Database and Statistics Estonia Database.

In Lithuania the share of textiles and textile articles has declined the most, however the share of other groups of products also changed significantly in 2004-2008. The crisis in 2009 brought notable changes only to the share of the leading products. Also in Estonia significant structural changes occurred in 2000-2007. However, in 2009-2011 the share of machinery and electrical equipment returned to its level prior to 2004. In all three countries significant structural changes can be observed mainly in the leading product groups.

Analysis of import structure by product groups shows that major changes in Latvia occurred in 2007-2009 (see Fig. 5 a), however it is not the case of Lithuania and Estonia. It is interesting to note that in Lithuania (see Fig. 5 b) import structure changed in 2000-2004 and again in 2004-2008, but mainly in opposite direction. There are several important changes also in 2009-2011. In Estonia the most significant changes occurred in all reference years at least in two product groups (see Fig. 5 c).

In Latvia, the recent crisis brought significant changes in import structure, however, in other Baltic countries import structure is more influenced by the process of transition from a centrally planned economy to a free market, which is completed now.

Figure 5 – Structure of Import of Goods by Principal Commodity Sections, %

a) Latvia

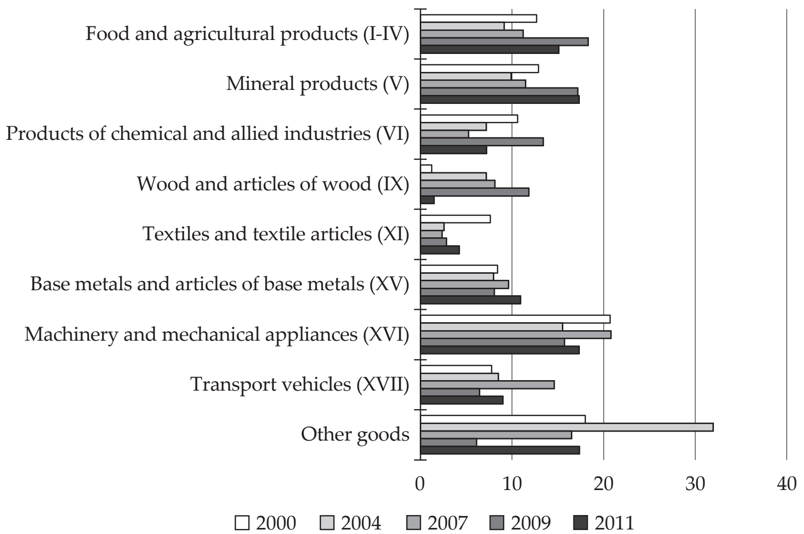
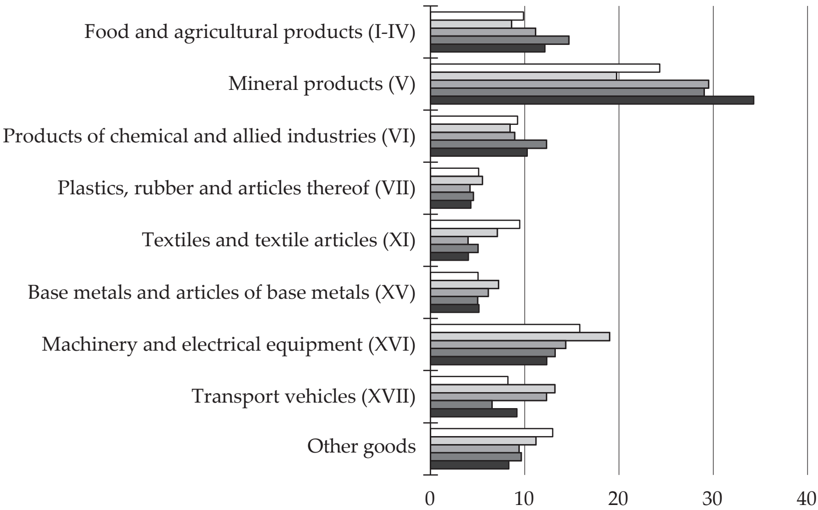
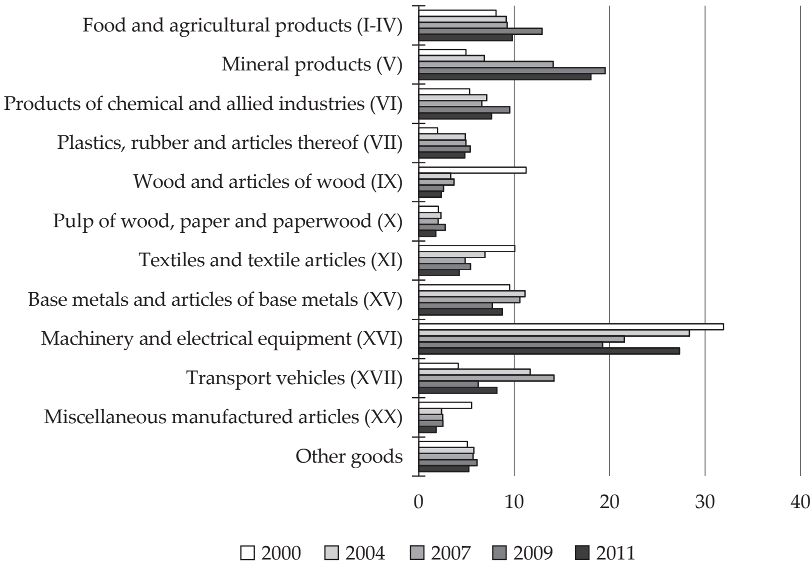


Figure 5 – Structure of Import of Goods by Principal Commodity Sections, % (continued)

b) Lithuania



c) Estonia



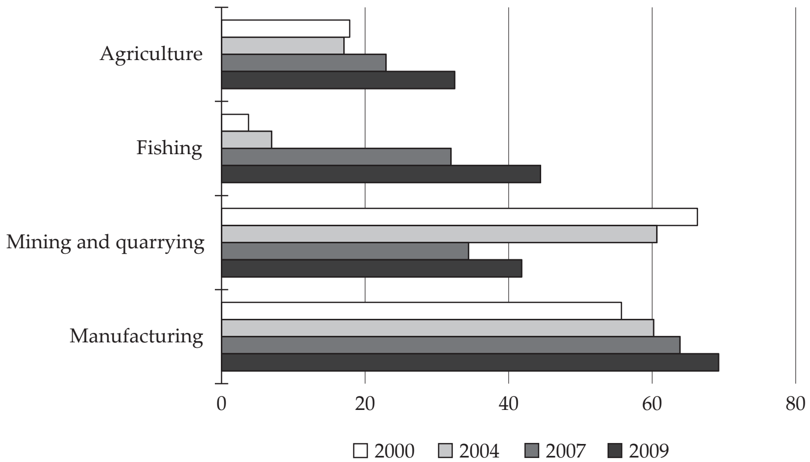
Source: Authors' calculation based on CSB Database, Statistics Lithuania Database and Statistics Estonia Database.

When analyzed by industries, export and import of goods corresponds mostly to manufacturing industry (D). In 2000-2009 the share of manufacturing in export structure fluctuates from 82% to 92% and in import structure, 78% to 93%. Agriculture (A) accounts for 5-9% of export and 2-4% of import, while the share of mining and quarrying (C) is only 1-2% of export and 2-6% of import. The share of fishing (B) is close to zero in both cases.

Agriculture, fishing, mining and quarrying and manufacturing can all be regarded as export-oriented industries, as the value of export orientation in 2009 exceeded 30% (see Fig. 6), however only in manufacturing the value of the ratio exceeds 50% since 2000 and is almost 70% in 2009. Export share grew steadily in manufacturing, significantly in agriculture and sharply in fishing, while during the fast development years export share in mining and quarrying almost halved.

It is worth to stress that the export-oriented industries are analyzed in this part of the research only by major groups due to the unavailability of time-series of more disaggregated data in corresponding classification.

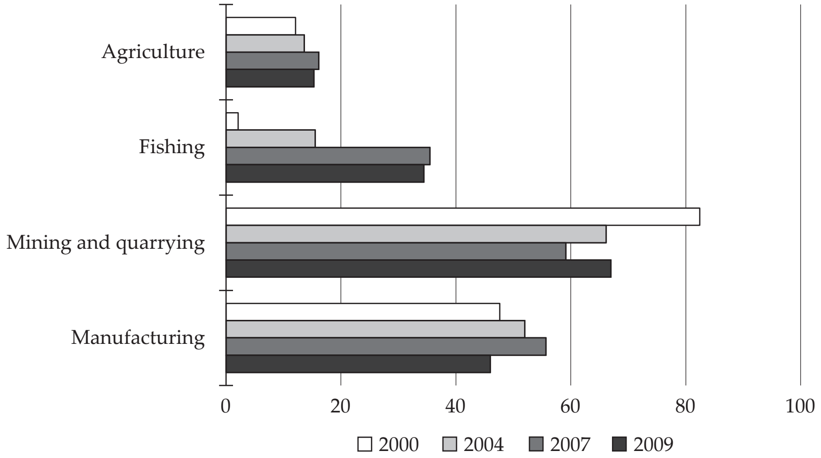
Figure 6 – Export Orientation Ratios, %



Source: Authors' calculation based on CSB Database

Import share is relatively small in agriculture, medium in fishing and manufacturing and high in mining and quarrying (see Fig. 7). While import share in fishing significantly grew in 2000-2007, it was declining in mining and quarrying in the same period. Notable changes in 2007-2009 occurred in mining and quarrying (import share increased) and in manufacturing (import share declined).

Figure 7 – Import Shares, %



Source: Authors' calculation based on CSB Database

On the basis of analysis of the economic structure and its dynamics in Latvia (according to NACE 1.1 Rev.) from 2000-2009 it is observable that the shares of industries in the economy are fluctuating; however it is clear that the process of major structural changes (as they were observable in the early and mid-1990's) is not evident.

B. Analysis of Input-output tables and modelling

The analysis of export by branches using input-output data (use tables) of the Baltic countries indicates that the importance of export by branch varies significantly from one branch to another (in most cases, goods-producing industries show larger export ratio values rather than service industries) (See Appendix 3). The branches that are more oriented to export in Latvia are Manufacture of wood and wood products, Manufacture of basic materials. At the same time, a considerable large number of service sector's branches have the value close to zero due to no export or very low level of export (especially, in public services). Nevertheless, if two reference years are compared (2004 and 2007), it is observable that not so notable changes had took place.

The analysis of gross sectoral productivity reveals that it gradually increases from a year to year, at the same time, a significant objective dispersion is observable. Productivity level of Wholesale and retail trade (G), Construction (F), Hotels and restaurants (H), and Real estate, renting and business activities (K) are very various and unlike despite general trend of these sectors (see Table 1).

As the number of employed persons is used in computation, it is one of the causes of these results since a person can work full-time, half-time or periodically over-time job. International comparison's results are presented in Appendix 4 and 5.

The dynamics and international comparison of the ratio of output per unit spent on compensation of employees show that majority of industry demonstrate relatively close results (see Table 2). Of course, there are differences in certain industries regarding applied technologies that can be significantly different (including different labour intensity and productivity), for example energy sector (electricity production by hydropower (in Latvia), nuclear plant (in Lithuania till recently), oil shale (in Estonia).

Table 1 – Labour productivity (thsd. euros per employed person)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total	*18,0*	*19,5*	*19,9*	*20,3*	*23,0*	*26,4*	*32,2*	*39,3*	*42,7*	*39,1*
A	6,0	6,9	6,7	7,2	8,8	10,4	11,5	16,6	20,4	18,2
B	32,7	30,8	23,9	19,5	19,7	23,6	26,2	35,6	33,7	35,9
C	12,3	17,2	18,1	20,2	24,6	28,9	39,7	54,1	52,4	49,2
D	20,7	23,0	23,3	25,3	29,1	33,2	39,8	47,1	47,6	43,4
E	39,4	41,2	48,8	50,1	49,0	54,2	77,0	104,1	125,2	138,9
F	22,0	22,0	27,8	24,9	30,3	34,9	45,0	52,3	57,4	55,5
G	16,4	17,7	17,9	17,3	19,3	21,4	26,7	30,8	29,0	23,9
H	12,0	12,3	13,2	9,7	11,1	14,3	18,4	20,3	19,4	16,0
I	31,7	32,2	31,5	30,6	36,2	39,4	40,9	48,7	55,2	48,7
J	36,0	45,4	43,0	42,1	44,5	51,8	76,5	84,6	87,1	79,1
K	27,4	33,7	30,3	31,1	36,7	47,3	55,8	66,3	66,0	64,5
L	13,7	15,8	17,5	17,9	18,0	19,0	23,1	28,9	35,9	32,3
M	7,2	7,6	8,0	8,7	8,7	9,2	10,8	13,6	16,2	15,1
N	8,6	9,5	10,0	10,1	12,0	11,7	13,7	17,1	18,9	17,1
O	15,7	16,2	16,2	15,3	19,1	19,5	22,5	26,5	31,9	29,9
A	-67%	-65%	-66%	-64%	-62%	-60%	-64%	-58%	-52%	-54%
B	81%	58%	20%	-4%	-15%	-10%	-19%	-9%	-21%	-8%
C	-32%	-12%	-9%	0%	7%	10%	23%	38%	23%	26%
D	15%	17%	17%	25%	26%	26%	24%	20%	12%	11%
E	119%	111%	145%	147%	113%	106%	139%	165%	193%	255%
F	22%	13%	40%	23%	31%	32%	40%	33%	34%	42%
G	-9%	-9%	-10%	-15%	-16%	-19%	-17%	-21%	-32%	-39%
H	-33%	-37%	-34%	-52%	-52%	-46%	-43%	-48%	-55%	-59%
I	76%	65%	58%	51%	57%	49%	27%	24%	29%	25%
J	100%	132%	116%	108%	93%	97%	138%	115%	104%	102%
K	52%	73%	52%	54%	59%	79%	73%	69%	55%	65%
L	-24%	-19%	-12%	-12%	-22%	-28%	-28%	-26%	-16%	-17%
M	-60%	-61%	-60%	-57%	-62%	-65%	-67%	-65%	-62%	-61%
N	-52%	-52%	-50%	-50%	-48%	-56%	-57%	-56%	-56%	-56%
O	-13%	-17%	-19%	-24%	-17%	-26%	-30%	-33%	-25%	-24%

Table 2 – Ratio of output to compensation to employees by branches

	2004	2007		
Code	Latvia	Latvia	Estonia	Lithuania
01	15,0	7,3	6,4	8,5
02	7,9	11,7	7,6	3,4
05	7,5	10,5	9,2	6,8
10	4,6	5,0	:	6,8
14	5,5	5,2	5,2	6,5
15	8,4	7,0	7,2	6,9
17	5,4	4,5	4,5	5,8
18	4,7	3,9	3,4	4,6
19	5,7	4,3	3,8	5,7
20	8,6	6,4	6,9	5,7
21	8,9	6,0	7,9	5,7
22	5,3	4,5	4,0	4,6
24	5,0	4,5	10,5	9,6
25	8,8	6,8	6,0	5,4
26	10,5	6,3	6,0	5,3
27	13,8	10,3	6,6	5,5
28	6,1	6,0	6,1	4,8
29	4,7	4,5	4,1	4,6
31	6,6	5,0	6,1	6,0
34	7,4	6,7	5,7	5,4
35	4,5	4,7	4,7	4,4
36	4,8	8,3	4,5	5,0
40	7,1	10,3	9,6	6,4
41	3,5	4,9	5,2	4,5
45	9,3	5,9	4,5	3,7
50	5,8	4,4	3,3	2,9
51	6,0	4,4	3,8	3,2
52	3,0	2,7	2,9	2,6
55	4,7	3,0	3,5	2,3
60	5,2	5,3	4,6	5,3
63	9,5	8,9	8,9	8,1
64	6,4	5,8	7,3	5,6
65	5,7	4,0	4,0	4,5
66	2,8	3,1	5,3	4,4
67	1,5	4,2	6,4	2,9
70	10,6	12,6	16,3	15,7
71	4,6	9,1	7,9	6,7
72	3,4	2,6	2,5	3,1
73	2,2	3,0	1,9	2,7
74	3,9	3,3	2,9	3,0
75	2,4	2,2	1,9	2,4
80	1,4	1,4	1,6	1,3
85	2,3	1,8	1,9	1,6
90	2,8	2,8	4,4	1,7
91	5,1	3,3	2,4	4,7
92	3,6	3,0	3,3	3,2
93	5,0	3,7	5,0	3,5
Total	5,1	4,6	4,4	4,1

: no data.
Sectors 11, 12, 13, 16, 23, 30, 32, 33, 37, 61, 62 are excluded due to no data.

The results of the analysis of the ratios of value added to compensation of employees and value added to wages and salaries by sector are presented in Table 3 and 4.

Table 3 – Ratio of value added to compensation to employees by branches

	Latvia			Estonia	Lithuania	Difference in 2007 (%)	
	1998	2004	2007	2007	2007	from Estonia	from Lithuania
01	3,1	5,8	2,5	2,7	3,3	-9%	-24%
02	1,7	2,4	5,0	3,4	1,9	48%	159%
05	2,4	2,2	5,1	3,4	1,5	52%	242%
14	1,4	4,5	2,3	2,9	3,0	-23%	-24%
15	1,7	1,8	1,7	1,6	2,0	6%	-17%
17	1,3	1,1	1,4	1,3	2,0	4%	-31%
18	1,4	1,8	1,3	1,2	2,0	9%	-37%
19	0,7	1,4	1,5	1,1	2,0	37%	-27%
20	1,8	1,8	1,7	1,7	2,0	2%	-17%
21	3,2	2,0	1,8	2,1	2,0	-14%	-13%
22	1,5	1,8	1,6	1,5	2,0	7%	-21%
24	1,2	1,7	1,7	2,6	2,0	-34%	-17%
25	1,9	1,9	1,7	1,5	2,0	15%	-16%
26	2,0	2,1	1,8	2,4	2,0	-23%	-10%
27	1,1	3,4	2,3	1,4	2,0	56%	11%
28	1,9	1,7	2,0	1,6	2,0	28%	-2%
29	0,9	1,7	2,0	1,4	2,0	40%	-4%
31	1,1	0,7	1,8	1,5	2,0	17%	-12%
34	0,7	1,1	1,7	1,6	2,0	2%	-18%
35	1,1	1,2	1,5	1,3	2,0	16%	-27%
36	1,4	1,9	2,6	1,4	2,0	87%	26%
40	2,3	2,5	3,1	3,8	2,8	-19%	9%
41	2,8	1,4	3,4	3,3	2,8	2%	20%
45	2,1	2,2	1,3	1,7	1,8	-28%	-31%
50	2,8	3,0	2,3	1,7	1,8	35%	24%
51	3,7	3,6	2,1	2,1	2,1	1%	-1%
52	2,1	2,1	1,5	1,7	2,0	-14%	-25%
55	1,6	2,4	1,4	1,4	1,4	1%	-6%
60	1,5	1,5	2,2	1,7	3,0	29%	-25%
63	2,5	6,0	2,0	2,5	3,8	-19%	-48%
64	2,6	3,5	2,9	3,3	3,7	-13%	-22%
65	2,6	2,9	2,5	2,3	3,2	10%	-22%
66	1,5	1,2	1,6	2,3	1,9	-32%	-17%
67	4,8	1,3	2,2	3,3	1,6	-33%	40%
70	2,3	8,0	7,2	12,1	10,9	-40%	-34%
71	3,7	2,9	5,0	4,6	4,1	9%	21%
72	2,5	1,7	1,3	1,5	1,9	-8%	-28%
73	1,0	1,2	1,3	1,1	1,8	18%	-23%
74	2,4	1,8	1,5	1,6	1,8	-6%	-19%
75	1,2	1,4	1,5	1,2	1,6	23%	-7%
80	1,1	1,1	1,1	1,1	1,0	-3%	4%
85	1,3	1,2	1,2	1,2	1,0	-2%	13%
90	1,8	1,5	1,3	2,0	1,1	-34%	23%

Table 3 – Ratio of value added to compensation to employees by branches (continued)

	Latvia			Estonia	Lithuania	Difference in 2007 (%)	
	1998	2004	2007	2007	2007	from Estonia	from Lithuania
91	1,0	1,3	1,2	1,1	1,5	10%	-18%
92	1,9	2,0	1,7	1,7	1,5	0%	13%
93	1,4	3,7	1,8	2,3	2,2	-23%	-18%
Total	1,8	2,3	1,9	1,9	2,1	-2%	-10%

: no data.
Sectors 10, 11, 12, 13, 16, 23, 30, 32, 33, 37, 61, 62 are excluded due to no data.

Table 4 – Ratio of value added to wages and salaries by branches

	Latvia		Estonia	Lithuania	Difference (%)	
Code	2004	2007	2007	2007	from Estonia	from Lithuania
01	6,9	2,8	3,6	3,9	28%	41%
02	2,7	6,0	4,4	2,4	-26%	-59%
05	2,6	7,5	4,4	1,9	-41%	-75%
10	2,1	2,2	:	3,9	:	73%
14	5,4	2,5	3,9	3,9	58%	57%
15	2,2	1,9	2,1	2,6	10%	33%
17	1,4	1,6	1,8	2,6	9%	57%
18	2,1	1,5	1,6	2,6	6%	74%
19	1,6	1,7	1,4	2,6	-16%	47%
20	2,2	1,9	2,2	2,6	14%	33%
21	2,5	2,0	2,7	2,6	33%	25%
22	2,1	1,8	2,0	2,6	8%	41%
24	2,1	1,9	3,4	2,6	77%	33%
25	2,3	2,0	2,0	2,6	1%	30%
26	2,5	2,1	3,1	2,6	49%	21%
27	4,2	2,6	1,9	2,6	-28%	-3%
28	2,0	2,3	2,1	2,6	-10%	11%
29	2,1	2,3	1,9	2,6	-19%	11%
31	0,9	2,1	2,0	2,6	-3%	23%
34	1,3	1,9	2,1	2,6	11%	32%
35	1,5	1,7	1,7	2,6	0%	51%
36	2,2	3,0	1,8	2,6	-39%	-14%
40	3,1	3,8	5,0	3,7	31%	-4%
41	1,8	4,2	4,4	3,7	5%	-12%
45	2,6	1,4	2,3	2,3	67%	69%
50	3,6	2,6	2,2	2,3	-14%	-11%
51	4,2	2,4	2,7	2,7	14%	13%
52	2,5	1,7	2,2	2,4	34%	43%
55	2,9	1,5	1,7	1,8	14%	16%
60	1,9	2,6	2,1	3,7	-16%	46%
63	7,2	2,3	3,3	4,8	41%	106%
64	4,3	3,4	4,4	4,8	31%	41%
65	3,6	3,1	3,0	4,4	-3%	43%
66	1,5	1,9	3,1	2,5	64%	30%
67	1,4	2,6	4,4	2,2	69%	-16%
70	9,6	8,1	15,9	13,7	96%	68%

Table 4 – Ratio of value added to wages and salaries by branches (continued)

Code	Latvia 2004	Latvia 2007	Estonia 2007	Lithuania 2007	Difference (%) from Estonia	Difference (%) from Lithuania
71	3,5	5,7	5,8	5,2	3%	-8%
72	2,1	1,5	1,9	2,3	25%	53%
73	1,4	1,7	1,5	2,2	-11%	30%
74	2,2	1,6	2,0	2,2	24%	38%
75	1,8	2,0	1,7	2,2	-14%	9%
80	1,4	1,4	1,5	1,4	3%	-6%
85	1,4	1,5	1,6	1,4	5%	-6%
90	1,8	1,5	2,6	1,6	75%	5%
91	1,6	1,5	1,5	1,9	-3%	23%
92	2,3	2,0	2,3	2,1	12%	2%
93	4,3	2,0	3,0	2,6	50%	29%
TOTAL	2,7	2,2	2,5	2,6	14%	20%

: no data.
Sectors 11, 12, 13, 16, 23, 30, 32, 33, 37, 61, 62 are excluded due to no data.

The values of labour input coefficient by logics should and are different for various industries. However, it is worth to stress that on average in the economy the value of this coefficient is 0.22-0.25. And the evidence indicates that more intersectoral differences are observed rather than international differences. Another important point is that despite grand changes regarding the values of indicators above-analysed, labour input coefficients have not changed by such an extent. The computational results are summed and presented in Appendix 6.

The analysis of labour input coefficients and labour productivity is notable element in labour demand analysis and forecasting. During the time period when the economic growth is accompanied with corresponding productivity growth it can lead to a situation when high unemployment arises and sustains for years. As free movement of labour force is one of the EU foundations, short-term or long-term emigration and immigration gradually balance the labour market and labour supply.

The obtained results are valuable and applicable in updating process of Latvia's INFORUM-type model and its data base as foreign trade is modeled within the model or exogenous (import by branches are modeled by import shares, but export by branches are exogenous). Latvia's INFORUM-type model is not linked to other INFORUM models.

Conclusions

The evidence of foreign trade analysis shows that the export structure in three Baltic countries are different, therefore also structural changes differ. However, in all countries the years of faster development brought by the most significant changes in export structure and the EU enlargement was a significant driver of change. Notable changes can be observed also during recession. However, the revived growth did not have much influence on export structure in Latvia, while there were significant changes in Lithuania and Estonia.

The findings about import structure show that, in Latvia, the recent crisis brought significant changes in import structure, however, in other Baltic countries import structure is more influenced by the process of transition from a centrally planned economy to a free market, which is completed now.

The evidence of sectoral data analysis on basis of IO tables shows that relative indicators (ratios) more correctly represent the sectoral specifics and latest trends. On the basis of international comparison with Estonia and Lithuania, it is concluded that a convergence is observable to Estonia's level. It is also concluded that despite notable changes regarding the values of indicators, labour input coefficients have not changed by such an extent and difference from the level in neighboring countries is relatively low. At the same time, the results of ratio of export and total use indicate that export-orientation significantly varies among the branches within the economy. This trend is observed in all Baltic countries that were studied. The obtained results are valuable and applicable in updating process of Latvia's INFORUM-type model and its data base.

Appendices

Appendix 1 – Notation of sectors according to NACE 1.1.Rev.

Code	Description
A	Agriculture, hunting and forestry
B	Fishing
C	Mining and quarrying
D	Manufacturing
E	Electricity, gas and water supply
F	Construction
G	Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods
H	Hotels and restaurants
I	Transport, storage and communication
J	Financial intermediation
K	Real estate, renting and business activities
L	Public administration and defence; compulsory social security
M	Education
N	Health and social work
O	Other community, social and personal service activities

Appendix 2 – Notation of branches according to NACE 1.1.Rev. (disaggregated)

No	Code	Description
01	A01	Agriculture, hunting and related service activities
02	A02	Forestry, logging and related service activities
05	B	Fishing
10	CA10	Mining of coal and lignite; extraction of peat
11	CA11	Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction, excluding surveying
12	CA12	Mining of uranium and thorium ores
13	CB13	Mining of metal ores
14	CB14	Other mining and quarrying
15	DA15	Manufacture of food products and beverages
16	DA16	Manufacture of tobacco products
17	DB17	Manufacture of textiles
18	DB18	Manufacture of wearing apparel; dressing; dyeing of fur
19	DC	Manufacture of leather and leather products
20	DD	Manufacture of wood and wood products
21	DE21	Manufacture of pulp, paper and paper products
22	DE22	Publishing, printing and reproduction of recorded media
23	DF	Manufacture of coke, refined petroleum products and nuclear fuel
24	DG	Manufacture of chemicals, chemical products and man-made fibres
25	DH	Manufacture of rubber and plastic products
26	DI	Manufacture of other non-metallic mineral products
27	DJ27	Manufacture of basic metals
28	DJ28	Manufacture of fabricated metal products, except machinery and equipment
29	DK	Manufacture of machinery and equipment n.e.c.
30	DL30	Manufacture of office machinery and computers
31	DL31	Manufacture of electrical machinery and apparatus n.e.c.
32	DL32	Manufacture of radio, television and communication equipment and apparatus
33	DL33	Manufacture of medical, precision and optical instruments, watches and clocks
34	DM34	Manufacture of motor vehicles, trailers and semi-trailers
35	DM35	Manufacture of other transport equipment
36	DN36	Manufacture of furniture; manufacturing n.e.c.
37	DN37	Recycling
40	E40	Electricity, gas, steam and hot water supply
41	E41	Collection, purification and distribution of water
45	F	Construction
50	G50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel
51	G51	Wholesale trade and commission trade, except of motor vehicles and motorcycles
52	G52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods
55	H	Hotels and restaurants
60	I60	Land transport; transport via pipelines
61	I61	Water transport
62	I62	Air transport
63	I63	Supporting and auxiliary transport activities; activities of travel agencies
64	I64	Post and telecommunications

Appendix 2 – Notation of branches according to NACE 1.1.Rev. (disaggregated) (continued)

No	Code	Description
65	J65	Financial intermediation, except insurance and pension funding
66	J66	Insurance and pension funding, except compulsory social security
67	J67	Activities auxiliary to financial intermediation
70	K70	Real estate activities
71	K71	Renting of machinery and equipment without operator and of personal and household goods
72	K72	Computer and related activities
73	K73	Research and development
74	K74	Other business activities
75	L	Public administration and defence; compulsory social security
80	M	Education
85	N	Health and social work
90	O90	Sewage and refuse disposal, sanitation and similar activities
91	O91	Activities of membership organization n.e.c.
92	O92	Recreational, cultural and sporting activities
93	O93	Other service activities
95	P	Activities of households
	Q	Extra-territorial organizations and bodies

Appendix 3 – Ratio of export to total use (by branches)

	2004			2007		
Sector	LV	EE	LT	LV	EE	LT
01	0,036	0.026	0,097	0,101	0,099	0,236
02	0,212	0,236	0,192	0,177	0,201	0,306
05	0,267	0,327	0,015	0,267	0,293	0,042
10	0.560	:	0,267	0,666	:	0,348
11	0,030	0,117	0,022	0,000	0,127	0,026
14	0,017	0,070	0,030	0,008	0,069	0,071
15	0,116	0,179	0,183	0,157	0,196	0,228
17	0,367	0,436	0,343	0,359	0,408	0,465
18	:	0,465	0,644	0,310	0,372	0,399
19	0,117	0,231	0,176	0,089	0,231	0,129
20	0,639	0,522	0,371	0,519	0,483	0,359
21	0,147	0,243	0,171	0,215	0,373	0,251
22	0,036	0,102	0,057	0,089	0,139	0,108
24	0,202	0,257	0,429	0,187	0,288	0,362
25	0,158	0,187	0,231	0,183	0,244	0,309
26	0,099	0,194	0,116	0,105	0,198	0,119
27	0,324	0,364	0,392	0,509	0,456	0,425
28	:	0,215	0,180	0,155	0,240	0,240
29	0,162	0,203	0,200	0,130	0,307	0,296
31	:	0,318	0,356	0,196	0,491	0,367
34	0,142	0,239	0,300	0,178	0,300	0,301
35	:	0,318	0,470	0,240	0,390	0,362
36	0,329	0,433	0,365	0,155	0,393	0,439
40	0,010	0,075	0,073	0,007	0,100	0,031
41	0,000	0,000	0,000	0,000	0,000	0,000
45	0,015	0,035	0,010	0,005	0,036	0,009

Appendix 3 – Ratio of export to total use (by branches) (continued)

	2004			2007		
Sector	LV	EE	LT	LV	EE	LT
50	0,001	0,003	0,000	0,000	0,009	0,000
51	0,048	0,803	0,512	0,296	0,796	0,462
52	0,000	0,009	0,000	0,000	0,030	0,000
55	0,132	0,014	0,000	0,000	0,012	0,188
60	0,551	0,166	0,446	0,454	0,204	0,638
63	0,226	0,431	0,336	0,204	0,386	0,300
64	0,062	0,090	0,068	0,060	0,101	0,079
65	0,182	0,083	0,032	0,283	0,130	0,042
67	:	0,055	0,000	0,250	0,227	0,002
70	0,006	0,006	0,000	0,000	0,004	0,000
71	0,143	0,235	0,019	0,136	0,145	0,035
72	0,173	0,173	0,154	0,163	0,269	0,054
73	0,149	0,168	0,123	0,178	0,189	0,223
74	0,157	0,113	0,090	0,167	0,142	0,051
75	0,008	0,009	0,007	0,008	0,019	0,013
80	0,000	0,002	0,000	0,000	0,001	0,000
85	0,000	0,001	0,003	0,002	0,002	0,007
90	0,002	0,003	0,000	0,003	0,003	0,000
91	0,000	0,000	0,000	0,000	0,000	0,000
92	0,012	0,034	0,024	0,023	0,027	0,055
93	0,000	0,038	0,003	0,000	0,048	0,003
95	:	0,000	0,000	0,000	0,000	0,000
Total	*0,160*	*0,216*	*0,208*	*0,147*	*0,217*	*0,221*

: no data.
Sectors 12, 13, 16, 23, 30, 32, 33, 37, 61, 62, 66 are excluded due to no data.

Appendix 4 – Difference of sectoral productivity in Latvia from Estonia (%)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total	*-23%*	*-26%*	*-31%*	*-34%*	*-33%*	*-32%*	*-25%*	*-20%*	*-14%*	*-12%*
A	-62%	-63%	-63%	-67%	-65%	-63%	-62%	-56%	-53%	-48%
B	75%	64%	-5%	-15%	59%	40%	15%	47%	-44%	-63%
C	-33%	-23%	-31%	-32%	16%	-6%	-6%	14%	12%	13%
D	-36%	-36%	-42%	-36%	-32%	-35%	-33%	-22%	-20%	-17%
E	22%	-9%	-10%	-21%	-13%	-4%	20%	3%	4%	9%
F	-8%	-19%	-15%	-22%	-14%	-21%	-5%	8%	24%	26%
G	1%	-3%	-13%	-29%	-27%	-32%	-21%	-23%	-20%	-25%
H	15%	-4%	-7%	-44%	-47%	-25%	-16%	-16%	-18%	-24%
I	-19%	-31%	-35%	-39%	-43%	-39%	-37%	-39%	-36%	-39%
J	-21%	-19%	-28%	-33%	-33%	-40%	-23%	-20%	-4%	25%
K	-27%	-30%	-35%	-39%	-43%	-28%	-26%	-23%	-23%	-13%
L	-16%	-5%	-6%	-15%	-8%	-14%	-6%	0%	6%	-6%
M	-18%	-11%	-7%	-6%	-17%	-18%	-10%	-8%	4%	8%
N	-11%	-1%	-4%	-1%	7%	-17%	-11%	-12%	-28%	-26%
O	41%	26%	5%	-10%	-6%	-6%	1%	6%	12%	9%

Appendix 5 – Difference of sectoral productivity in Latvia from Lithuania (%)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
TOTAL	*20%*	*13%*	*8%*	*3%*	*5%*	*4%*	*12%*	*19%*	*9%*	*20%*
A	12%	10%	9%	27%	26%	9%	1%	6%	-14%	7%
B	675%	340%	-82%	-67%	-55%	-13%	-29%	-8%	26%	15%
C	-71%	-68%	-43%	-31%	-33%	-47%	-16%	34%	-5%	21%
D	-19%	-25%	-21%	-22%	-28%	-28%	-24%	-16%	-31%	-22%
E	51%	55%	-1%	-11%	-5%	-16%	15%	54%	68%	50%
F	36%	25%	47%	22%	41%	55%	70%	66%	60%	131%
G	21%	12%	3%	-2%	5%	5%	29%	31%	7%	1%
H	21%	0%	4%	-24%	-8%	10%	53%	29%	28%	9%
I	35%	11%	-6%	-11%	1%	-6%	-17%	-9%	-14%	-14%
J	40%	24%	18%	37%	19%	20%	38%	44%	12%	68%
K	-25%	-19%	-14%	-24%	-18%	-8%	11%	-3%	10%	35%
L	-26%	-16%	-9%	-17%	-18%	-15%	-19%	4%	5%	10%
M	48%	37%	19%	24%	18%	24%	15%	38%	33%	21%
N	32%	54%	55%	53%	64%	32%	45%	45%	23%	8%
O	33%	27%	18%	9%	33%	40%	37%	42%	42%	41%

Appendix 6 – Labour input coefficient

	2004	2007				Difference from average (%)			2007/1998
Sector	LV	LV	EE	LT	Average	LV	EE	LT	LV
01	0,07	0,14	0,16	0,12	0,14	0%	13%	-14%	1,6
02	0,13	0,09	0,13	0,30	0,17	-50%	-23%	73%	0,4
05	0,13	0,09	0,11	0,15	0,12	-19%	-7%	26%	0,6
10	0,22	0,20	:	0,15	:	:	:	:	0,5
14	0,18	0,19	0,19	0,15	0,18	8%	7%	-14%	0,6
15	0,12	0,14	0,14	0,15	0,14	0%	-2%	2%	0,8
17	0,19	0,22	0,22	0,17	0,21	8%	8%	-16%	0,9
18	0,21	0,26	0,30	0,22	0,26	0%	15%	-15%	1,3
19	0,18	0,23	0,26	0,18	0,22	5%	17%	-21%	0,9
20	0,12	0,16	0,14	0,18	0,16	-1%	-9%	11%	0,9
21	0,11	0,17	0,13	0,17	0,16	7%	-19%	12%	1,4
22	0,19	0,22	0,25	0,22	0,23	-3%	9%	-6%	0,9
24	0,20	0,22	0,10	0,10	0,14	58%	-32%	-26%	1,1
25	0,11	0,15	0,17	0,18	0,17	-11%	1%	11%	1,0
26	0,10	0,16	0,17	0,19	0,17	-7%	-3%	10%	0,8
27	0,07	0,10	0,15	0,18	0,14	-33%	6%	27%	0,9
28	0,16	0,17	0,16	0,21	0,18	-7%	-9%	16%	1,0
29	0,21	0,22	0,24	0,22	0,23	-2%	7%	-5%	0,6
31	0,15	0,20	0,17	0,17	0,18	13%	-7%	-6%	0,9
34	0,14	0,15	0,18	0,19	0,17	-13%	4%	9%	1,0
35	0,22	0,21	0,21	0,23	0,22	-2%	-2%	4%	0,5
36	0,21	0,12	0,22	0,20	0,18	-33%	23%	10%	0,6
40	0,14	0,10	0,10	0,16	0,12	-19%	-12%	31%	0,4
41	0,28	0,21	0,19	0,22	0,21	0%	-7%	7%	0,8
45	0,11	0,17	0,22	0,27	0,22	-23%	1%	22%	0,9
50	0,17	0,23	0,30	0,34	0,29	-22%	4%	18%	1,2
51	0,17	0,23	0,26	0,32	0,27	-16%	-2%	18%	1,7

Appendix 6 – Labour input coefficient (continued)

	2004	2007				Difference from average (%)			2007/1998
Sector	LV	LV	EE	LT	Average	LV	EE	LT	LV
52	0,34	0,37	0,35	0,38	0,37	1%	-6%	4%	1,4
55	0,21	0,33	0,29	0,43	0,35	-6%	-18%	24%	1,6
60	0,19	0,19	0,22	0,19	0,20	-5%	9%	-5%	0,6
63	0,11	0,11	0,11	0,12	0,12	-3%	-3%	6%	0,7
64	0,16	0,17	0,14	0,18	0,16	6%	-16%	10%	0,7
65	0,18	0,25	0,25	0,22	0,24	5%	3%	-8%	0,9
66	0,36	0,32	0,19	0,23	0,25	31%	-23%	-7%	1,8
67	0,67	0,24	0,16	0,35	0,25	-4%	-37%	41%	1,5
70	0,09	0,08	0,06	0,06	0,07	17%	-10%	-7%	0,4
71	0,22	0,11	0,13	0,15	0,13	-15%	-1%	16%	0,6
72	0,30	0,38	0,40	0,33	0,37	4%	9%	-12%	1,5
73	0,45	0,33	0,52	0,37	0,41	-20%	28%	-9%	0,5
74	0,26	0,30	0,34	0,33	0,32	-8%	5%	3%	1,3
75	0,41	0,46	0,52	0,42	0,47	-1%	11%	-9%	1,0
80	0,74	0,71	0,62	0,75	0,69	2%	-10%	8%	1,1
85	0,43	0,56	0,52	0,64	0,57	-2%	-10%	12%	1,2
90	0,35	0,36	0,23	0,57	0,39	-7%	-42%	48%	1,3
91	0,20	0,31	0,41	0,21	0,31	-1%	32%	-31%	0,6
92	0,28	0,33	0,31	0,31	0,32	5%	-3%	-2%	1,0
93	0,20	0,27	0,20	0,29	0,25	8%	-22%	14%	0,9
Total	*0,20*	*0,22*	*0,23*	*0,25*	*0,23*	*-5%*	*-1%*	*7%*	*0,9*

: no data.
Sectors 11, 12, 13, 16, 23, 30, 32, 33, 37, 61, 62 are excluded due to no data.

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Study of Relationship between Demographic Structure Change and Economic Structure in China

Introduction

The feature of Chinese demographic structure is changing from a high fertility rate, high death rate and low life expectancy to low fertility rate, low death rate and high life expectancy, and the phenomena of ageing population in coming future will become more serious. The data of Sixth National Population Census show that the ageing rate of the population is higher than expectations, the share of population with age 60 years and above is 13.26%, the share of population with age 65 years and above is 8.87%; average number of members of each household is 3.10 persons, this figure is 0.34 person less than 3.44 persons of Fifth National Population census in 2000. This demographic structural change has not only increased the burden of social security pension and reduced the active labor force; it will also influence the saving rate and consumption structure and further affect the economic structure and sustainability of China's economic development.

Currently, most of the studies related to the impact of China's demographic structural change on economy is based on macro-perspective, such as analysis of impact of structural change of demographic age on saving rate and also its impact on future potential economic growth. However there is no study to analyze the impact of demographic structural change on Chinese economy from structural perspective. But it is important to study this issue for a developing transitional economy by

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focusing on structural change from micro-perspective. Therefore, this paper starts the study to analyze change of consumption structure of household of various age structure based upon survey data of CHIPS (Chinese Household Income Project) to explore the changing relationship between China's demographic structure and consumption structure. Moreover, I/0 model is applied on this basis to study the impact of demographic structural change on economic and employment structure from comparative static perspective.

Relationship between demographic structure and consumption structure

It is a common thought that aging population will not only effect the relative ratio between consumption and saving, but also it may affect directly the consumption structure, for example, the demand of medical and health care service of the elders will far exceed that of the youth. But there is nearly no domestic quantitative data which reflects directly the relationship between population structure and consumption structure. The National Bureau of Statistics of China generally announces only the data of consumption structure based upon income groups, there is no information related to population structure in correspondence. Currently, there is only one available database to be substitute, i.e. survey data of CHIPS (Chinese Household Income Project). This database includes data of household consumption and age of head of household, and the variation of age of head of household of different household can be used to reflect the change of population age structure. This study used the survey data of the year 1995, 2002 and 2007 of CHIPS (Chinese Household Income Project) to analyze the changing relationship between household with head of household of different ages and consumption structure.

The following content lists the statistical results of grouping of urban Result of analysis of rural household is basically similar to urban household. Concrete results are shown in appendix of this paper. This study classifies the households with age structure of house holder in 25-70 years into 9 groups with interval of age of five years; in addition, two groups of household with age of house holder below 25 years (25 years included) and age of head of household above 70 years (70 years included) there are 11 groups all together.

In order to compare the change of consumption structure in the year 1995, 2002 and 2007, diagrams showing the change of share of consumption of 8 categories to total consumption with the change of age of house holders is prepared in this paper (Please see the attached appendix).

Table 1 – The Consumption Structure of urban household according the age of the head of household in 2007 (%)

Age of Head	Food	Clothing	Residence	Equipment and daily necessities	Health care and medical services	Transportation and communication	Education, culture and recreation service	Others	Total
25-29	38.00	11.95	15.73	8.20	5.41	9.59	6.88	4.25	100
30-34	39.00	11.53	11.60	7.52	5.75	9.48	10.93	4.19	100
35-39	39.12	10.61	9.44	7.11	5.84	11.30	12.03	4.56	100
40-44	41.13	10.03	8.09	5.71	6.17	8.89	15.50	4.47	100
45-49	40.61	9.21	7.80	5.66	5.39	10.23	17.28	3.82	100
50-54	41.94	9.82	11.86	6.30	6.90	9.36	9.69	4.14	100
55-59	45.38	9.31	7.83	6.39	8.12	9.47	9.62	3.88	100
60-64	47.67	8.38	9.76	5.99	10.00	7.74	6.54	3.92	100
65-69	50.35	7.86	7.84	4.94	13.31	6.39	5.53	3.77	100

With reference to the data of consumption structure of 2007, the following facts are shown.

1. Average share of food consumption is above 40%; there is increase of share of food consumption post retirement because of decrease of their income.
2. The share of consumption of clothing, residence, transport and communications shows a declining trend with the growth of age.
3. The share of expenses on health care and medical services increases with the increase of age, and it raises relatively faster post the age of sixty.
4. The share of expenses on education, culture and recreation service varies with changing age in the shape of inverted U, peak appears in households with the age of the head around 45-49 years.

Therefore, the consumption structure of the old people is different explicitly with the young people, the age of the head of households has important impact on consumption structure, with the consumption of health care and medical service within the eight large categories of consumption of urban household, the share of health care and medical service is around 5.41% for the group with age of the head of households around 25-29 years, while this figure is 13.31% for the group with age of the householder around 65-69 years.

The major features of change of consumption structure from 1995 to 2007 are shown in the following:

1. There are nearly no significant changes of share of expenditure on food and clothing of urban household, the relationship with the age of house holder is basically similar from 1995 to 2007; the share of expenditure on clothing has a declining trend with increasing of age, while the expenditure on food is in rising with the increasing of age.
2. There are relatively large changes of share on expenditure of residence, health care and medical service, transport and communication from 1995 to 2007. The share of expenditure on residence is around 2% in 1995, it is risen to above 8% in 2002 and 2007. The share of expenditure on health care is around 3% in 1995, and there are no significant changes in accompanying the change of age. It is increased to above 6% in 2007, it shows a rising trend in accompanying the increasing of ages. The share of expenditure of transport and communication is around 2% in 1995, and it has nearly no change with the change of ages, it is risen above 9% in 2002 and 2007, and it has a declining trend in accompanying the increasing of ages.
3. There are relatively large changes of share of expenditure on education, culture and recreation in the year of 1995, 2002 and 2007, the share of expenditure on education, culture and recreation is the lowest in the year 1995 while it is the highest in 2002. It may be questioned why it is declined in 2007? This may be related to exemption of education cost around that year. In addition, the share of expenditure on education, culture and recreation has an inverted "U" structure with the age of head of household, the peak value appeared in the same age group, i.e. in the household with age of house holder from 45-49 years old.

It can be seen that there is significant relationship between the age structure of house holder and consumption structure of household from previous analysis, or to express the fact in different way, there are significant differences of consumption structure of household with different age groups. In short, the following rules are existed either from the cross section data or panel data: consumption of food increases with the increase of age of house holder; share of consumption of clothing, transport and communication decreases with the increase of age of house holder; the share of consumption of health care and medical services increases rapidly in accompanying the increase of age of the house holder; the share of consumption of education, culture and recreation has inverted "U" shape with the change of age.

Design of scenario of structural change of population and the method of analysis of its impact on economic structure

Design of Scenario

In order to study the impact of structural change of the population, it is necessary to design the possible scenarios of structural change of the population. By the mean time, in order to combine better this study with China's reality, the scenario of China's Population Projection under conditions of various birth rate policies done by ZengYi and JiangLaiwei in 2009 is used to be the basis of design of this study. It is necessary to point out that the projection done by Zeng Yi and Jiang Laiwen (2009) is projection based on households, i.e. projection of change of future number of households and average number of persons per household with house holder of different age groups.

Their studies can be better combined with previous analysis on the relationship between population structure and consumption structure. This paper chooses the age structure of the population in 2050 with scenario of different fertility rate under three different birth rate policies described in Zeng and Jiang (2009) studies to be the targeted population structure (Refer to table 2) with 1 low fertility scenario, 2 medium fertility scenario, 3 high fertility scenario. It is also needed to be stressed that static comparative method is used in this paper, i.e. change of other factors such as urbanization rate and scale of population is not considered in this study except the age structure of population.

Table 2 – Design of Scenario

Scenario	Main assumptions
Baseline (2007)	The population structure in 2007: 1. The ratio of the household which the age of head of is above 60 years old is 5.23%. 2. The ratio of the household which the age of head of is above 65 years old is 3.3%.
Scenario 1 (LOW)	Maintain the existing family planning policy (only one child per family except both couple are only child): 1. The ratio of the household which the age of head of is above 60 years old is 36.34%. 2. The ratio of the household which the age of head of is above 65 years old is 26.07%.
Scenario 2 (Medium)	Promoting "Two children for couples either one is only children" and "Two children with late childbearing": 1. The ratio of the household which the age of head of is above 60 years old is 31.45% 2. The ratio of the household which the age of head of is above 65 years old is 22.61%.
Scenario 3 (High)	Completely release the two-children policy, the fertility rate surged: 1. The ratio of the household which the age of head of is above 60 years old is 27.99% 2. The ratio of the household which the age of head of is above 65 years old is 20.06%.

Comparative static analytic method is used in this study, and population structure in 2007 is chosen to be the base scenario.

In scenario 1, the current family planning policy will be maintained (families with father and mother are both only child, second birth is allowed, only one child is permitted for other families), the fertility rate will be lower, degree of aging will be more serious than the base scenario, the share of the population for the household with age of head of household above 65 years will reach 26.07%, which is 23 percentage higher than the base scenario; in scenario 2, it is assumed to Promote "Two children for couples either one is only children" and "Two children with late childbearing", the fertility rate will be higher than scenario 1, and the aging rate is slightly lower. In scenario 3, it is assumed to promote "Two children for all couples", the fertility rate will be much higher, and while the degree of aging is much lower than scenario 1 and 2; but comparing with basic scenario the degree of aging is very serious.

Methodology

The change of demographic structure can impact on economic structure in many paths such as varying structure of consumption, saving/investment rate, supply of labor. This paper just focuses on the change of consumption structure. This results is derived through two steps, Firstly, impact of population age structure of different scenarios on the consumption structure is estimated. Then, further calculation is done to estimate the impact on industrial structure through change of consumption structure. From the view of literature, Input-output model is usually used to analyze the impact of changing of consumption structure on economic structure. The input-output identities are as follows:

$$X = (I - A^d)^{-1} Y$$

Where, X is the vector of total sectoral output. A^d is the matrix of domestic intermediate input coefficients and Y is the vector of final demand. This is standard Leontief's "demand-driven" I-O model. To analyze the impact of change of demand, the differentials of this equation is choose,

$$\Delta X = (I-A^d)^{-1} \Delta Y$$

Where, Δ is change of demand or output. With this equation, total effect on the production can be captured, when final demand changes by one unit.

To get the effect on employment, the following function is used,

$$\Delta L = l\, \Delta X = l(I-A^d)^{-1} \Delta Y$$

Where, ΔL is change of employment, i.e. effect on employment of change of final demand. l is employment intensity for each sector.

Impact of demographic change on economic structure

Based upon previous design of different scenarios with targeted population age structure, and also using the quantitative relationship between population age structure and consumption structure, it is possible to estimate the consumption structure in correspondence with the targeted population age structure under different scenarios. Then applying further the I/0 model introduced previously to estimate the change of total output of each sector of different scenarios in correspondence with targeted population age structure, the impact of change of different population age structure on economic structure can be compared further. Analysis of results of estimation of industrial structure and employment structure will be given in the following:

Table 3 – The Industrial Structure of Each Scenario (%)

	Baseline Industrial Structure	Scenario 1 (Low)		Scenario 2 (Medium)		Scenario 3 (High)	
		Industrial Structure	Change	Industrial Structure	Change	Industrial Structure	Change
Primary industry	10.77	10.83	0.57%	10.83	0.50%	10.82	0.40%
Secondary industry	50.55	50.70	0.28%	50.68	0.26%	50.68	0.25%
Coal mining and Washing	1.66	1.66	-0.23%	1.66	-0.17%	1.66	-0.14%
Oil and gas exploration	2.14	2.10	-1.87%	2.11	-1.54%	2.11	-1.31%
Metals mining and dressing	0.81	0.81	0.14%	0.81	0.14%	0.81	0.15%
Non-metallic minerals and other mining and Dressing	0.57	0.58	1.36%	0.57	1.15%	0.57	1.01%
Food manufacturing and tobacco processing	3.83	3.85	0.74%	3.85	0.63%	3.84	0.49%
Textile	1.85	1.81	-1.88%	1.82	-1.47%	1.83	-1.11%
Textile, leather and Related Products	1.52	1.42	-6.23%	1.44	-4.99%	1.46	-3.98%
Wood processing and furniture manufacturing	0.98	0.99	0.98%	0.99	0.82%	0.99	0.73%
Paper printing and Educational and Sports Goods	1.34	1.33	-0.24%	1.33	-0.26%	1.33	-0.25%
Petroleum processing, coking and nuclear fuel processing	1.41	1.41	-0.30%	1.41	-0.24%	1.41	-0.19%
Chemical Industry	4.73	4.76	0.55%	4.76	0.50%	4.75	0.45%
Non-metallic mineral products	2.35	2.39	1.69%	2.39	1.41%	2.38	1.24%
Metal smelting and rolling processing	4.48	4.53	1.06%	4.52	0.89%	4.52	0.80%

Table 3 – The Industrial Structure of Each Scenario (%) (continued)

	Baseline Industrial Structure	Scenario 1 (Low)		Scenario 2 (Medium)		Scenario 3 (High)	
		Industrial Structure	Change	Industrial Structure	Change	Industrial Structure	Change
The production and supply of electricity, heat	3.31	3.28	-1.01%	3.28	-0.82%	3.29	-0.72%
Gas production and supply	0.08	0.08	-3.05%	0.08	-2.51%	0.08	-2.21%
Water production and supply industry	0.21	0.20	-3.22%	0.20	-2.67%	0.20	-2.36%
Fabricated Metal Products	1.39	1.40	0.98%	1.40	0.83%	1.40	0.75%
General, special equipment manufacturing	3.43	3.48	1.45%	3.47	1.22%	3.46	1.08%
Transportation equipment manufacturing	2.41	2.41	-0.11%	2.41	-0.09%	2.41	-0.04%
Electrical machinery and equipment manufacturing	1.74	1.75	0.59%	1.75	0.52%	1.75	0.49%
Communications, computers and other electronic equipment manufacturing	2.56	2.57	0.63%	2.57	0.54%	2.57	0.51%
Instrumentation , cultural and office machinery manufacturing	0.39	0.39	-0.34%	0.39	-0.30%	0.39	-0.26%
Artwork and Other Manufacturing	0.58	0.58	-0.23%	0.58	-0.14%	0.58	-0.04%
Scrap waste	1.33	1.33	0.37%	1.33	0.31%	1.33	0.29%
Construction	5.46	5.57	2.12%	5.55	1.77%	5.54	1.55%
Tertiary industry	38.67	38.47	-0.52%	38.49	-0.47%	38.50	-0.44%
Transportation and warehousing industry	5.50	5.49	-0.06%	5.49	-0.04%	5.50	-0.01%
Postal services	0.13	0.13	-0.88%	0.13	-0.75%	0.13	-0.62%
Information transmission, computer services and software	2.26	2.20	-2.96%	2.21	-2.46%	2.22	-2.05%
Wholesale and retail trade	6.51	6.59	1.11%	6.58	0.94%	6.5	0.79%
Accommodation and catering	2.09	2.11	0.67%	2.10	0.56%	2.10	0.44%
Financial	5.05	5.04	-0.18%	5.04	-0.15%	5.04	-0.10%
Real estate	4.63	4.39	-5.30%	4.43	-4.37%	4.45	-3.85%
Leasing and Business Services	1.43	1.43	0.05%	1.43	0.04%	1.43	0.05%
Research and experimental development	0.23	0.23	0.44%	0.23	0.37%	0.23	0.34%
Comprehensive technical service	0.89	0.90	1.06%	0.90	0.89%	0.90	0.79%

Table 3 – The Industrial Structure of Each Scenario (%) (continued)

	Baseline Industrial Structure	Scenario 1 (Low)		Scenario 2 (Medium)		Scenario 3 (High)	
		Industrial Structure	Change	Industrial Structure	Change	Industrial Structure	Change
Water conservancy, environment and public facilities management industry	0.42	0.43	3.91%	0.43	3.31%	0.43	2.81%
Resident Services and Other Services	1.51	1.41	-6.49%	1.42	-5.95%	1.43	-5.42%
Education	2.75	2.66	-3.25%	2.66	-3.08%	2.67	-2.84%
Health, social security and social welfare	1.43	1.57	9.40%	1.55	8.00%	1.53	6.74%
Culture, Sports and Entertainment	0.57	0.56	-2.53%	0.56	-2.38%	0.56	-2.18%
Public administration and social organizations	3.26	3.34	2.33%	3.33	1.95%	3.32	1.71%

Analysis of impact of change of population age structureon industrial structure.

Table 3 gives the estimated results of impact of population age structure of different scenarios on industrial structure. Hereunder, analysis will be given on the difference of industrial structure under scenario 1 to the base scenario to be example, because there is largest change of population age structure in scenario1 based upon the design. From the estimated results of table3, the difference of impact of change of population structure on various industrial sectors is very large. It shows the following major features.

1. Service sector is affected the most from change of population age structure, but there are large differences of impact for different service sectors. It can be seen from the results listed on table3, the assumption for scenario 1, the continuity of current policy on birth rate will result high aging population in the future and it will have larger impact on the development of future service sector. The service sector can be classified mainly into following categories based upon the degree of impact. The first category, aging population will bring about large development of public service industries such as medical service and health care which will be 1.57%, increased by 9.4% compared to 1.43% of base scenario. The second category, aging population will reduce the demand of development of education and related public service industry. Aging population in scenario1 will lead the decline of 3.25% of share of education compared to the based scenario. The third category, aging population will be unfavorable to the development of consumer service, aging population in scenario1 will result the decline of 6.49%, 5.3% and 2.53% of share of service to household and other services, real estate, culture,

sports and entertainment compared to the base scenario; The fourth category, aging population will result unfavorable impact on the development of producer service. Aging population in scenario 1 will cause the decline of share by 2.96%, 0.88% and 0.06% of information transmission, computer service and software, post, transport and warehouse industry compared to the base scenario.

2. Population age structure has relatively minor impact to manufacturing and mining industry as a whole. It can be seen from the result of estimation listed in table 3 that the impact of change of population structure to above two industries can be classified into two categories. First category, change of population age structure has larger impact on consumption goods and energy production related industries. Aging population in scenario 1 will result the decline of share by 6.23%, 3.05%. 1.01% and 1.87% of textile wearing apparel, gas, production and supply of electric power, extraction and production of petroleum of natural gas industry compared to the base scenario. Second category, change of population age structure has relatively minor impact on other sectors.
3. Change of population age structure has relatively minor impact to agriculture.

It can be seen from table 3 that even in the case of scenario 1 with highest degree of aging population, the agricultural sector has relatively minor impact from the increasing of aging of population.

The impact of change of population age structure with industrial structure of scenario 2 and 3 has more or less similar feature to scenario 1. Due to the degree of aging population in scenario2 and 3 is less then scenario 1, therefore the corresponding degree of impact is lower than scenario 1, especially, the impact of change of population structure on industrial structure is the smallest among all.

Analysis of impact of change of population structure on the employment structure

Table 4 presents the impact of change of population age structure on the employment structure. It can be concluded that the impact of population age structure on employment structure is similar with the impact to industrial structure from the result shown in the table, i.e., change of population age structure has large impact on service employment, while the impact to manufacturing job is relatively small. Discussing concretely, employment post effected the highest by the change of population structure is post of public service related closely with the living of old people, the demand of employment post such as health care, social security and social welfare will be increased tremendously, the share of demand of employment post of above sectors to total employment will be increased around 9% compared to the base scenario. This means, in accompanying the acceleration of aging population in the future, demand of technical personnel specialized in nursing and health care of old people will be raised tremendously. Contrarily, employment post related closely to the living of old people will be effected greater negatively by the population structural change, such as employment post of real estate, clothing, education, energy and entertainment sectors. This is due to decline of demand of these sectors to the old relative the youth. Results listed on table 4 show, share of employment of resident service and other services, manufacture of textile, wearing apparel, footgear and hats, leather products, feather and others, real estate, education, water production and supply, gas production and supply in scenario 1 will be declined 6.7%, 6.45%, 5.52%, 3.47%, 3.45% and 3.28% compare to the base scenario.

Employment of other sectors will be less effected by the structural change of the population.

Table 4 – Employment Structure of Each Scenario (%)

	Baseline	Scenario 3 (low)		Scenario 2 (medium)		Scenario 1 (High)	
		Employment structure	Changes	Employment structure	Changes	Employment structure	Changes
Primary industry	40.80	40.94	0.33%	40.92	0.30%	40.90	0.24%
Secondary industry	26.80	26.94	0.53%	26.92	0.46%	26.92	0.44%
Extractive industries	1.15	1.14	-0.90%	1.14	-0.73%	1.14	-0.61%
Coal mining and Washing	0.37	0.37	-0.46%	0.37	-0.36%	0.37	-0.30%
Oil and gas exploration	0.47	0.46	-2.10%	0.47	-1.73%	0.47	-1.47%
Metals mining and dressing	0.18	0.18	-0.09%	0.18	-0.05%	0.18	-0.01%
Non-metallic minerals and other mining and Dressing	0.13	0.13	1.12%	0.13	0.95%	0.13	0.86%
Food manufacturing and tobacco processing	1.80	1.81	0.50%	1.81	0.44%	1.80	0.33%
Textile	0.87	0.85	-2.10%	0.85	-1.66%	0.86	-1.26%
Textile, leather and Related Products	0.71	0.67	-6.45%	0.68	-5.17%	0.68	-4.12%
Wood processing and furniture manufacturing	0.46	0.46	0.75%	0.46	0.63%	0.46	0.58%
Paper printing and Educational and Sports Goods	0.63	0.63	-0.47%	0.63	-0.45%	0.63	-0.40%

Table 4 – Employment Structure of Each Scenario (%) (continued)

	Baseline	Scenario 3 (low)		Scenario 2 (medium)		Scenario 1 (High)	
		Employment structure	Changes	Employment structure	Changes	Employment structure	Changes
Petroleum processing, coking and nuclear fuel processing	0.66	0.66	-0.54%	0.66	-0.43%	0.66	-0.34%
Chemical Industry	2.22	2.23	0.32%	2.23	0.31%	2.23	0.30%
Non-metallic mineral products	1.11	1.12	1.45%	1.12	1.22%	1.12	1.09%
Metal smelting and rolling processing	2.11	2.12	0.82%	2.12	0.70%	2.12	0.64%
The production and supply of electricity, heat	0.55	0.54	-1.24%	0.54	-1.01%	0.54	-0.87%
Gas production and supply	0.01	0.01	-3.28%	0.01	-2.69%	0.01	-2.36%
Water production and supply industry	0.03	0.03	-3.45%	0.03	-2.86%	0.03	-2.51%
Fabricated Metal Products	0.65	0.66	0.75%	0.66	0.64%	0.66	0.60%
General, special equipment manufacturing	1.61	1.63	1.21%	1.63	1.02%	1.63	0.92%
Transportation equipment manufacturing	1.13	1.13	-0.34%	1.13	-0.28%	1.13	-0.20%
Electrical machinery and equipment manufacturing	0.82	0.82	0.36%	0.82	0.32%	0.82	0.33%
Communications, computers and other electronic equipment manufacturing	1.20	1.21	0.40%	1.21	0.35%	1.21	0.36%
Instrumentation, cultural and office machinery manufacturing	0.18	0.18	-0.57%	0.18	-0.49%	0.18	-0.41%
Artwork and Other Manufacturing	0.27	0.27	-0.46%	0.27	-0.33%	0.27	-0.20%
Scrap waste	0.62	0.62	0.14%	0.62	0.12%	0.62	0.13%

Table 4 – Employment Structure of Each Scenario (%) (continued)

	Baseline	Scenario 3 (low)		Scenario 2 (medium)		Scenario 1 (High)	
		Employment structure	Changes	Employment structure	Changes	Employment structure	Changes
Construction	8.00	8.15	1.88%	8.12	1.58%	8.11	1.40%
Tertiary industry	32.40	32.12	-0.85%	32.15	-0.76%	32.18	-0.67%
Transportation and warehousing industry	3.61	3.60	-0.29%	3.60	-0.23%	3.61	-0.16%
Postal services	0.09	0.09	-1.11%	0.09	-0.94%	0.09	-0.77%
Information transmission, computer services and software	6.79	6.58	-3.18%	6.62	-2.64%	6.64	-2.20%
Wholesale and retail trade	6.68	6.74	0.88%	6.73	0.75%	6.72	0.64%
Accommodation and catering	2.15	2.15	0.44%	2.15	0.37%	2.15	0.28%
Financial	0.60	0.60	-0.41%	0.60	-0.34%	0.60	-0.25%
Real estate	0.21	0.20	-5.52%	0.20	-4.55%	0.20	-4.00%
Leasing and Business Services	4.30	4.29	-0.18%	4.29	-0.15%	4.29	-0.10%
Research and experimental development	0.06	0.06	0.20%	0.06	0.18%	0.06	0.18%
Comprehensive technical service	0.23	0.23	0.82%	0.23	0.70%	0.23	0.63%
Water conservancy, environment and public facilities management industry	0.17	0.18	3.67%	0.18	3.11%	0.18	2.65%
Resident Services and Other Services	1.94	1.81	-6.70%	1.82	-6.13%	1.83	-5.57%
Education	2.30	2.22	-3.47%	2.23	-3.26%	2.23	-2.99%
Health, social security and social welfare	0.88	0.96	9.15%	0.94	7.79%	0.93	6.57%
Culture, Sports and Entertainment	0.48	0.47	-2.76%	0.47	-2.57%	0.47	-2.33%
Public administration and social organizations	1.91	1.95	2.09%	1.94	1.75%	1.94	1.55%

Major Conclusions and Policy Implications

This paper utilizes the CHIP data to analyze the relationship between age structure of the population and consumption, on this basis, I/0 model is applied to analyze the impact of change of various population age structure on industrial structure and employment structure through the impact of consumption structure.

Result of analysis shows, change of population age structure has the highest influence on service sector and its employment, but different service sectors will be effected in different natures and degrees by the change of population age structure. Demand of medical service and health care of public service which are closely related to aging population, such as medical and health case service will be increased tremendously, in correspondence, the demand of technical personnel specialized on medical service, health care and elder care will also be increased tremendously; the other related services and manufacturing sectors of the living demand of the old people will be effected negatively by the change of population age structure, especially the real estate, education, entertainment, textile and wearing apparel, energy sector, correspondingly, the employment opportunity will be reduced relatively greatly due to the trend of further aging of the population age structure; other manufacturing sector and producer service sector will be effected relatively smaller by the population age structure. In addition, through the comparison of different scenarios, it can be seen that change of the population policy may reduce the impact of change of population age structure on economic and employment structure to certain extent.

The above conclusions means, how to direct the industrial development and alter the employment structure to adapt to change of population age structure will become a huge challenge faced by China in a long coming period of the future. For example, in the area of medical service, health care and social security, it is necessary to consider to accelerate the development of medical service, health care and social security activities on the basis of equalization of provision of public service of them especially, these services related to aging population such as elder health care, retirement and elder care and proper pension system should be a major concern; there are needs to adjust the direction of development of education system continuously due to decline of amount of population receiving the basic education in accompanying the increasing aging population, education system should be transformed from focusing on quantity to quality, technical personnel specialized on education for aging population should be trained and cultivated; in addition, development of real estate and related manufacturing sectors should be adjusted in correspondence with the needs of change of population age structure.

Appendix

Figure 1 – The relation between the age of head of urban household and the ratio of food and clothes in 1995-2007

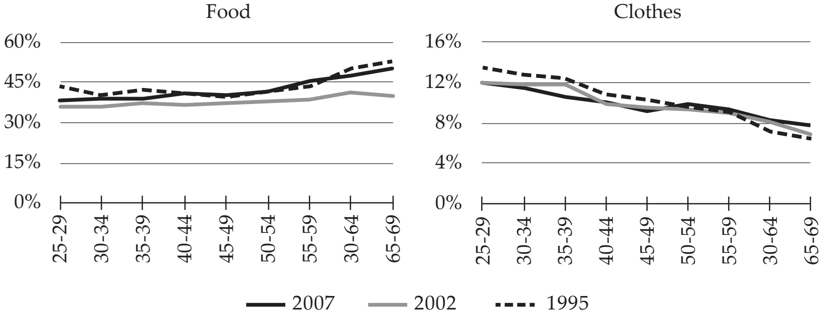

Figure 2 – The relation between the age of head of urban household and the ratio of resident and transportation and communication in 1995-2007

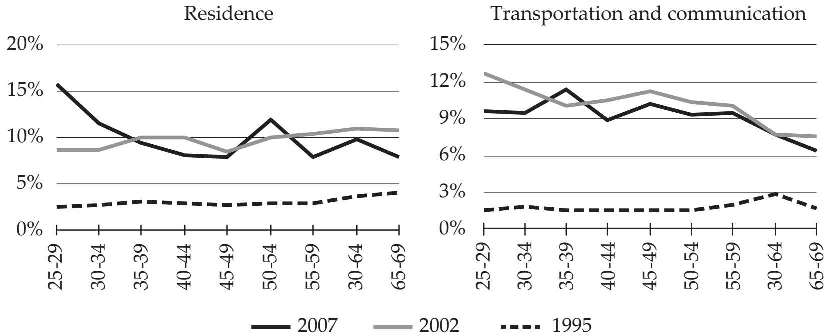

Figure 3 – The relation between the age of head of urban household and the ratio of Medical and social security and education in 1995-2007

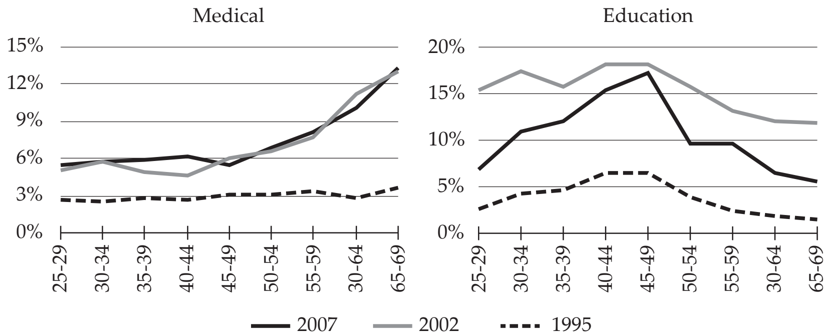

Table A-1 – Population structure of each scenario (%)

The age of the head	Baseline (2007)		Scenario 3 (High)		Scenario 2 (Medium)		Scenario 1 (Low)	
	rural	urban	rural	urban	rural	urban	rural	urban
Below 25 years	6.73	5.29	6.99	4.03	5.91	3.47	4.72	2.70
25-29	11.10	14.96	9.96	9.58	7.92	8.69	6.25	7.09
30-34	14.63	16.90	8.71	14.14	7.03	12.57	5.27	10.67
35-39	16.77	17.28	8.26	14.61	6.94	12.65	5.09	11.09
40-44	16.05	15.18	9.21	12.70	8.15	11.67	5.89	10.59
45-49	13.30	12.19	7.67	8.95	9.15	9.88	9.24	11.77
50-54	9.24	8.60	7.44	8.20	8.56	9.20	9.23	10.65
55-59	7.07	4.21	7.76	7.86	8.43	9.10	9.65	10.23
60-64	1.95	1.90	7.29	8.79	7.90	10.10	9.65	11.12
65-69	1.38	1.42	5.98	5.04	6.58	5.73	7.96	6.32
Above 70 years	1.79	2.06	20.73	6.12	23.43	6.95	27.05	7.76

Table A-2 – Consumption structure of each Scenario

	Baseline (2007)	Scenario 1 (High)	Scenario 2 (Medium)	Scenario 3 (Low)
Food	41.35	42.90	43.18	43.55
Clothes	9.26	8.78	8.63	8.45
Resident	12.57	11.97	11.89	11.73
Equipment and daily necessities	6.32	6.16	6.10	6.03
Medical and social security	6.17	7.11	7.29	7.50
Transportation and communication	10.09	9.64	9.54	9.43
Education and culture	10.57	9.73	9.65	9.60
Others	3.68	3.71	3.71	3.72
Total	*100*	*100*	*100*	*100*

Table A-3 – Consumption structure in input-out table

Sector	Baseline	Scenario 1 (High)	Scenario 2 (Medium)	Scenario 3 (Low)
Agriculture	11.55	11.99	12.08	12.18
Coal mining and Washing	0.15	0.15	0.14	0.14
Oil and gas exploration	-	-	-	-
Metals mining and dressing	-	-	-	-
Non-metallic minerals and other mining and Dressing	-	-	-	-
Food manufacturing and tobacco processing	17.28	17.94	18.06	18.22
Textile	0.46	0.41	0.40	0.39
Textile, leather and Related Products	5.87	5.29	5.13	4.94
Wood processing and furniture manufacturing	0.54	0.53	0.53	0.53
Paper printing and Educational and Sports Goods	0.44	0.40	0.39	0.39

Table A-3 – Consumption structure in input-out table (continued)

Sector	Baseline	Scenario 1 (High)	Scenario 2 (Medium)	Scenario 3 (Low)
Petroleum processing, coking and nuclear fuel processing	0.77	0.73	0.72	0.71
Chemical Industry	2.43	2.43	2.42	2.41
Non-metallic mineral products	0.29	0.30	0.30	0.30
Metal smelting and rolling processing	-	-	-	-
Fabricated Metal Products	0.43	0.42	0.42	0.42
General, special equipment manufacturing	0.07	0.07	0.07	0.07
Transportation equipment manufacturing	2.54	2.40	2.37	2.33
Electrical machinery and equipment manufacturing	1.99	1.99	1.98	1.97
Communications, computers and other electronic equipment manufaturing	2.01	2.00	1.99	1.98
Instrumentation , cultural and office machinery manufacturing	0.19	0.19	0.18	0.18
Artwork and Other Manufacturing	1.43	1.43	1.42	1.42
Scrap waste	-	-	-	-
The production and supply of electricity, heat	2.44	2.31	2.29	2.26
Gas production and supply	0.33	0.32	0.31	0.31
Water production and supply industry	0.33	0.32	0.31	0.31
construction	0.97	0.91	0.91	0.89
Transportation and warehousing industry	2.43	2.30	2.27	2.23
Postal services	0.06	0.06	0.06	0.06
Information transmission, computer services and software	3.09	2.91	2.87	2.83
Wholesale and retail trade	8.02	8.33	8.39	8.46
Accommodation and catering	5.95	6.18	6.22	6.28
Financial	4.29	4.39	4.40	4.42
Real estate	7.83	7.43	7.37	7.26
Leasing and Business Services	1.27	1.30	1.30	1.31
Research and experimental development	-	-	-	-
Comprehensive technical service	-	-	-	-
Water conservancy, environment and public facilities management industry	0.30	0.36	0.37	0.38
Resident Services and Other Services	4.15	3.78	3.74	3.72
Education	4.44	4.04	4.01	3.98
Health, social security and social welfare	4.85	5.69	5.85	6.04
Culture, Sports and Entertainment	0.79	0.72	0.71	0.71
Public administration and social organizations	-	-	-	-
Total	*100*	*100*	*100*	*100*

Notes: according to the corresponding relationship between the eight categories of consumer and 42 sectors of input-out table, we use the least squares method for the correction data.

V. Potapenko

Financing of growing pension expenditures in Russia to 2030

Introduction

Present and future conditions of pension system are the most discussable subject of Russian social policy agenda for last years. Partly, it is connected with fast growth of pension expenditures since 2009. But the main reason is inevitable and significant changes of demographic structure. In coming years, number of old people will increase and, simultaneously, number of people at working ages will fall. As a result, the task of supporting acceptable living standards of pensioners will become much more difficult.

Some experts and policy makers believe that it is necessary to accomplish a pension reform for successful functioning of pension system in a long-term period. Among of proposals are increase of retirement age, refusal of funded pensions, restricting requirements for getting complete pensions, and slow indexation of them. All these proposals have some disadvantages and they will not solve the problem of rising pension expenditures completely.

Probably, it will be unavoidable to raise social security contributions rates for financing of pensions. But it is rather unpopular step among Russian politicians and experts. They consider it very dangerous due to possible negative influence of raising social security contributions rates on economic development. In this paper, approach is proposed which lets get quantitative estimates of consequences of financing of rising pension expenditures by means of growing social contributions.

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Current conditions of Russian pension system

Russia uses for financing of pension expenditures pay-as-you-go (PAYG) and funded plans. Both of them are mandatory. In PAYG plan current employees and their employers pay social contributions that form benefits for current pensioners. And when these employees retire future workers provide benefits for them. In funded plans current social contributions are accumulated, invested and paid to today employees when they retire. Contributions and benefits are administrated by Pension Fund of Russian Federation (PFRF).

Funded plans are new for Russia – they were introduced in 2002. They take about 6.5 times less contributions than PAYG plan, so funded ones have minor significance in pension system now and will have in future. In this way, even in a long term period PAYG benefits will provide most of pensioners' income.

Russian PAYG pension consists of two parts: one is a flat-rate benefit that all pensioners get; second is an earnings-related part that depends on aggregate contributions of an employee for whole life (by-turn, the contributions depend on aggregate wage of the employee).

Pension expenditures are financed by social contributions for PAYG plan (they took about 63% of all expenditures on pension benefits in 2011) and federal budget (37%; the amount covers PFRF's budget deficit[1]). Significant amount of benefits from funded plans will be paid since 2022 only, but they will be several time less than PAYG ones.

In 2011 Russian pension expenditures was 7.4% of GDP. The highest value of the expenditures was one year earlier – 8.0% of GDP, the lowest value was in 2007 – 4.5% of GDP (in 2009-2010 pension benefits were increased considerably). Number of pension beneficiaries is 40.2 mln., that is 28.1% of population.

International comparison of pension systems' conditions

Retirement ages for Russian men and women are 60 and 55 years, respectively. These values are less than in most countries of Western and even Eastern Europe (table 1). Nevertheless, pension pressure on Russian economy is less than in most of European countries. For example, pension expenditures in Germany, France, UK, Italy are 4-9 percentage points of GDP above Russian ones. Some Eastern Europe's countries – Poland, Latvia, Czech Republic – spend on pension benefits much more than Russia too.

Demographic features of Russian pension system are not critical nowadays. So, pensioners take 28.1% of population and number of employed

[1] PFRF deficit is pension expenditures minus social contributions for PAYG plan.

persons on one pensioner is 1.74 – these values are quite comparable with European ones. Moreover, in France and Italy numbers of employed persons on one pensioner are much lower than in Russia, but it doesn't mean economic disaster for these countries.

Table 1 – Pension systems' indicators in some countries in 2011

	Retirement age		Pension expenditures, % of GDP	Number of pensioners, % of population	Number of employed persons on one pensioner
	Male	Female			
Russia	60	55	7.4	28.1	1.74
Germany	65.08	65.08	12.8	28.7	1.69
France	60	60	14.4	27.8	1.42
UK	65	60	12.2	22.3	2.09
Italy	66	62	16.0	27.3	1.39
Spain	65	65	10.8	19.2	2.04
Finland	65	65	12.7	27.1	1.69
Sweden	65	65	12.1	26.9	1.83
Norway	67	67	8.3	21.9	2.36
Portugal	65	65	14.2	27.9	1.64
Czech Republic	62.5	61.33	9.2	27.3	1.71
Slovakia	62	59.75	8.4	25.0	1.74
Poland	65	60	11.9	25.7	1.63
Latvia	62	62	10.0	29.0	1.62

Source: data on retirement age – «Social security programs throughout the world: Europe, 2012» by US SSA, other data - Russian Federal Service of State Statistics, Eurostat.

Because of relatively low pension expenditures, requirements for amount of social contributions in Russia are rather low too. In 2011 social contributions (most of them are used for pension benefits) were 6.3% of GDP. These indicators in most of European countries were far much higher (table 2). For instance, French, German and Czech social contibutions were 16.9, 15.8, and 15.4% of GDP, respectively.

There are two reasons for low value of Russian social contributions. The first one is low level of wages and salaries in economy – it was only 24.2% of GDP in 2011, so base for paying the contributions is rather little. The second reason is low nominal social contributions rates: Russian effective rate of social contributions was 26.2% in 2011. In Germany it was 35.0% and French value was 43.5%. Most of Eastern Europe's countries also had high effective rates.

In this way, international comparisons demonstrate that Russia has an enormous reserve for increase of social contributions rates. European countries' experience shows that sustainable development is possible with rather high social contributions' pressure on economy.

Table 2 – Social security system's indicators in some countries in 2011

	Actual social contibutions, % of GDP	Wages and salaries minus employees' social contributions, % of GDP	Effective rate of social contributions*, %
Russia	6.3	24.2	26.2
Germany	15.8	37.1	35.0
France	16.9	35.9	43.5
UK	7.8	45.4	16.7
Italy	13.4	30.4	38.2
Spain	12.1	36.4	28.6
Finland	12.7	39.2	29.8
Sweden	7.4	45.1	16.0
Norway	9.5	35.6	25.0
Portugal	9.3	38.2	23.6
Czech Republic	15.4	29.4	43.9
Slovakia	12.3	27.6	34.4
Poland	11.5	26.7	34.8
Latvia	8.6	32.5	26.2

* Ratio of emloyers' actual social contributions and employees' social contributions to wages and salaries minus employees' social contributions.
Source: Russian Federal Service of State Statistics, Eurostat.

Demographic forecast

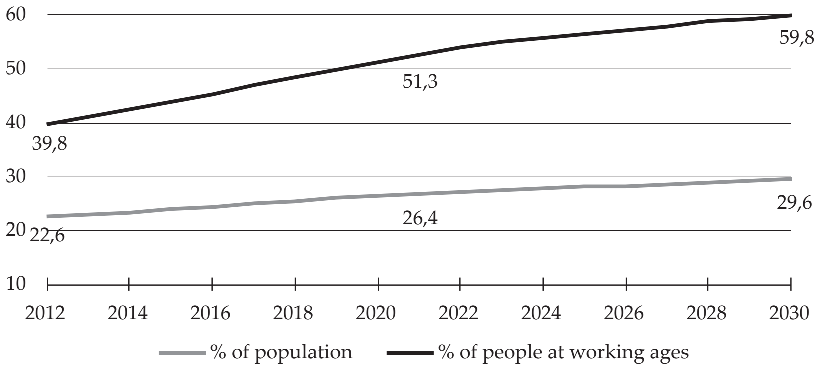
Demographic situation's change is a key factor that determines future pension expenditures. In order to take it into account we have built a demographic forecast. In the paper a medium variant of the forecast is introduced (using other variants affects results insignificantly as period considered in the paper ends in 2030).

Used demographic scenario presumes that by 2030 Russian age death rates will attain values typical for Eastern Europe countries nowadays (current death rates in Russia are much more than in the countries, particularly for men of working ages). Also the scenario presumes that net migration increase will save the value of 2011 year for whole period. The same presumption is taken about value of total fertility rate, although age fertility rates will change in direction of elder births.

According to medium variant of the forecast, Russian population in 2030 will be 137.0 mln. persons, now it is 143.1 mln. persons. But the population structure's changes will be much more important than decrease of whole population (figure 1). Number of people at retirement ages will increase from 32.4 mln. persons in 2012 to 37.0 mln. persons in 2020 and to 40.6 mln. persons in 2030. Simultaneously, number of people at working ages (20-59 years for men and 20-54 years for women) will decrease from 80.2 mln persons in 2012 to 72.2 and 67.8 mln. persons in 2020 and 2030, respectively.

As a result, ratio of number of people at retirement ages to number of people at working ages for next two decades will change dramatically: its value will rise by 20 percentage points – from 39.8 to 59.8%.

Figure 1 – People at retirement ages in Russia according to medium variant of demographic forecast



Source: author's calculations.

Growth of pension expenditures to 2030

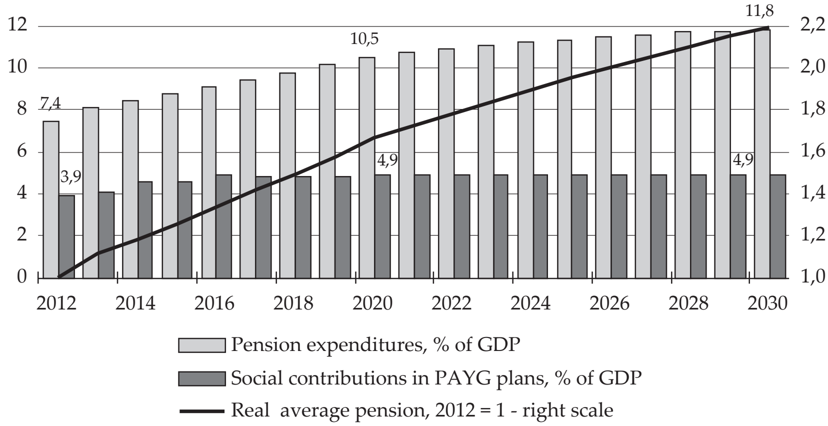
Rapid change of demographic situation will lead to appreciable growth of pension expenditures. (It is true in situation when acceptable living standards of pensioners are supported). Here we consider a scenario that presumes that ratio of average pension to average wage will rise by 40% by 2020 and will be at this level to 2030 (now the value is 35%; this indicator is usually used by Russian officials for comparisons of pensioners' living standards, and 40% is government aim value). In the case of realization of the scenario real average pension will increase by 1.66 times by 2020 and by 2.19 times by 2030 in comparison with 2012 (figure 2).

Simultaneously, pension expenditures will increase by 4.4 percentage points of GDP for eighteen years. Such expenditures will be 10.5% of GDP by 2020 and 11.8% of GDP by 2030[2]. But growth of social contributions for PAYG plan will not be so great: in 2012 they are 3.9% of GDP, in 2030 the value will be 4.9% of GDP. So, federal budget will be responsible for growing difference between pension expenditures and social contributions. Now the difference is 3.5%, but the value will be 7.0% of GDP in 2030

[2] Results presented in this section are calculated by means of Russian pension system's model developed in Institute of Economic Forecasting. The model is briefly discussed in the next sections.

(the results presume that share of wages and salaries in GDP is the same as in 2011 and nominal social contributions rates are not changed for whole considered period).

Figure 2 – Russian pension system's indicators



Note: Consumer price index is used for calculation of real average pension.
Source: author's calculations.

Growth of pension expenditures and, correspondingly, federal budget expenditures by 4 percentage points of GDP does not look great disaster. Moreover, international comparisons show that a lot of countries can direct 10% of GDP and more for pension benefits for many decades. Nevertheless, for providing efficient social policy it is necessary to understand mechanisms of financing of growing expenditures and their influence on economy.

Financing of pension expenditures' growth

Growing pension expenditures and necessity to find sources of their financing are considered as a very important problem in Russia. The most obvious solution to reduce pensions is increase of retirement age that is very low both for men and for women in Russia. There are an objection for the step concerning men – very high mortality among them will make higher retirement age very unjust. But demographic situation lets increase retirement age for women. According to our calculations, if by 2030 retirement age for women is 60 years (as for men), then pension expenditures will reduce by 1.1 percentage point of GDP. So, the step cannot solve the problem of growing expenditures completely. In addition, it is very unlikely that government will make so unpopular step as increase of retirement age.

Thereby, pension expenditures can be reduced hardly. Therefore sources of their financing should be found. One of these sources is reducing (or even refusal of) mandatory funded plans. The step was realized lately. Nominal contributions rate will be 2% of wage under threshold instead of 6% nowadays. The difference – 4% – will be directed to PAYG plan. According to our forecast, the step results in additional social contributions for PAYG plan that is only 0.6% of GDP in 2020 and 0.7% of GDP in 2030 (values on figure 2 take into account reducing of the rates).

The amount of social contributions can be increased if shadow economy's size decreases (it is enormous in Russia) that leads to bigger share of wages and salaries in GDP. So, if the share is 30% of GDP by 2030, social contributions for PAYG plan will be 5.8% of GDP (with 25% share the amount will be 4.9% of GDP). But outlooks of shadow economy's suppressing are vague, and it is recklessly to rely upon it only.

Besides, Russian government debt is very low and its budget usually had a surplus last decade. Thereafter, Russia has significant reserves for debt financing of pension expenditures. Nevertheless, such a step contradicts economic policy of many years and its realization seems improbable.

The most probable step that can be undertaken (with above-mentioned ones to be hardly realized) for financing of growing pension expenditures is increase of nominal rates of social contributions for PAYG plan. But the step causes great concern about its influence on economy.

Interconnection between pension system and economy

Pension expenditures have many ways to impact on economy situation. By-turn, macroeconomic conditions affect pension system too. There are main interconnection channels between pension system and economy (it is important that almost all these channels have significant interindustrial peculiarities).

Pension expenditures and final household consumption

Pension expenditures are mostly spent on items of household consumption. Therefore, forecast growth of amount of pensions by more than 4 percentage points of GDP will make final household consumption more almost these 4 points. Thus, it will have further influence on economic development.

It is principal that the growth will not be proportional for separate economic activities. The point is that for next years pensioners' living standards will rise together with economic development of Russia that will change structure of pensioners' consumption. So, future pension benefits will have serious impact on both amount of final household consumption and its structure.

Social contributions rates and final household consumption

For financing of social contributions if their rates are increased, companies can reduce their profits or wages of their employees (it is not reduction in absolute terms; it means that amount of profits or wages will be less than in case when rates are not increased). If growing contributions rates are financed by wages, then final household consumption decreases (wages are mostly spent for consumption). However, structures of employees' and pensioners' consumption differ greatly. So, this mode of pension benefits' financing does not change amount of household consumption seriously, but affects its structure that has macroeconomic consequences.

Social contributions rates and fixed capital formation

If growing contributions rates are financed by profits of companies, then fixed capital formation is reduced (in Russia companies' profits is the main financial source of fixed capital formation). That means a negative multiplicative effect for economy.

Social contributions rates and costs of different economic activities

These rates vary with size of employees' wages. Simultaneously, separate economic activities have different labor costs standards. Therefore efficient rates of social contributions for economic activities are different. Besides, their shares of labor costs in whole costs are diverse too. As a result, increase of social contributions rates changes costs of separate economic activities very differential.

Economic growth and pension expenditures

Growth of wage level depends strongly on economic development. By-turn, wage level determines growth of average pension benefits and finally their amount.

Model of Russian pension system

To analyze above-mentioned interconnections we need a model of Russian pension system, model of Russian economy and linkages between them. The model of economy must be interindustrial, because these interconnections have very important interindustrial features.

Pension system's model used for building a long-term forecast consists of several linked units: demographic, social contributions unit, pension calculations unit. All these ones are integrated into interindustrial model of Russian economy CONTO[3].

[3] Detailed description of CONTO can be found in [1], Russian pension system's model is described in [2].

CONTO includes a set of static input-output models in current and constant prices to 2030. The model is detailed for 44 economic activities. Part of its variables are exogenous – first of all these are variables of economic policy. But most of them are endogenous and calculated inside the model.

Demographic unit of pension system's model calculates number of people at one-year sex and age groups on the base of exogenous scenarios of fertility, mortality and migration. This data is directed to pension calculations unit and CONTO.

Exogenous variables of social contributions unit are nominal social contributions rates and thresholds. The unit determines values of effective social contributions rates for separate economic activities. The effective rates are directed to CONTO so as to find amount of social contributions.

Main exogenous variables of pension calculations unit are ones of pension legislation – retirement age, values of pension indexation and so on. The products of the unit are number of pensioners, amount of pension expenditures, average pension for all pensioners and for their different cohorts, amount of federal budget expenditures for covering Pension Fund of Russian Federation's budget deficit. CONTO directs to pension calculations unit data about amount of social contributions of different groups of employees, the data are used for calculating future pensions. Then determined amount of pension benefits is directed to CONTO to be distributed for final household consumption of different economic activities.

As shown above, for next years supporting acceptable pensioners' living standards will require growth of pension expenditures. The value of the increase is estimated in pension calculations unit. On figure 3 a scheme of complex modelling of the growth is imaged. In the paper two ways of financing of growing pension benefits are considered:

- Through profits of companies.
- Through wages and salaries of employees.

In reality, growth of pension expenditures can be financed by mix of the ways, and used model lets set proportions of their participation in financing.

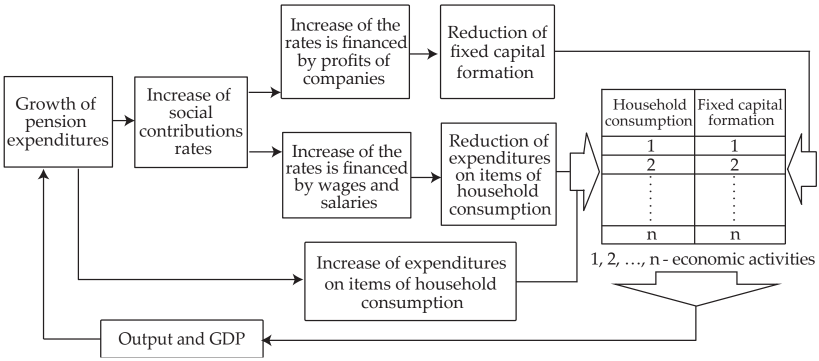
First of all, pension calculation unit computes average size of pensions and amounts of them for income groups of pensioners in current prices. Then the values are transformed into real prices with consumer price index. After it the amounts of benefits of the groups are corresponded with household consumption structures (detailed for economic activities) on the base of real average pensions of the groups (statistical base for the correspondence is retrospective micro data of Russian households budgets surveys). The procedure determines amount of final household consumption formed by pensioners that is directed to CONTO.

In the case of financing of pension expenditures' growth by increase of the rates, social contributions unit calculates differences between new and old efficient rates for economic activities and directs them to CONTO in which additional amount of contributions is found. If such financing is connected with profits of companies, then investments of economic activities for fixed capital formation are reduced.

If financing presumes fall of wages and salaries, then final household consumption is reduced by amount of additional social contributions (consumption structure of the amount is found in the same way as above-mentioned structures for groups of pensioners). It is important that CONTO has separate national and import matrixes, so changes of import and its influence on economic growth through different consumption patterns are taken into account.

Thus, pension expenditures' growth provokes significant changes of final demand that have important multiplicative effects. By-turn changes of economic situation affect pension benefits level, and then computation circle begins again.

Figure 3 – General scheme of growth of pension expenditures' modeling



Scenarios and results

Two scenarios of Russian pension system's development are considered. The first one – base scenario – presumes that pension expenditures will be at current level – 7.5% of GDP - to 2030. The realization of the scenario is unlikely, because it will lead to great fall of pensioners' living standards. But base scenario is useful for comparison with other pension system's strategies.

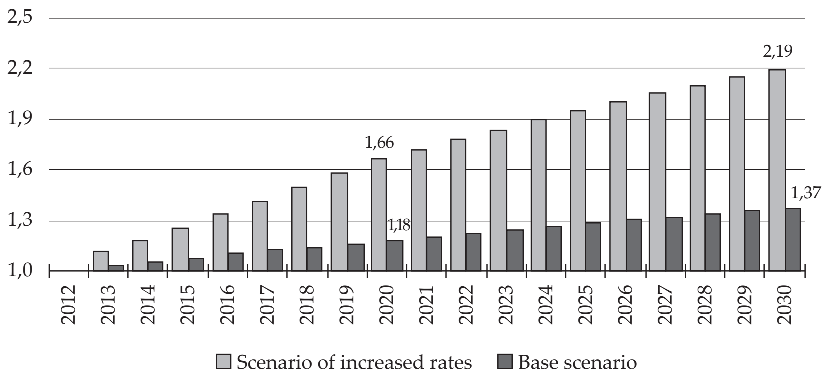
The second one – scenario of increased social contributions rates – assumes that ratio of average pension to average wage will rise to 40% by 2020 and stabilize at the level to 2030. Besides, the second scenario presumes that Pension Fund of Russian Federation's budget deficit will be approximately at current level. Consequently, the scenario provokes growth of pension expenditures which will be financed by increase of social contributions rates. Nominal rates' values for forecast period are set exogenously, so their efficient rates will be 30.1% in 2015, 37.3% in 2020, 39.4% in 2025 and 39.5% in 2030. In 2011 the efficient rate was 26.2%, thereby in the scenario it will gradually attain current values typical for France, Italy, Germany and Czech Republic.

Increase of the rates, accordingly to the scenario, is financed by both wages and salaries of employees and profits of companies (every of these two sources finances 50% of additional amount of social contributions). Comparison of calculations' results of two described scenarios lets determine possible consequences of growth of pension expenditures in Russia for next twenty years.

Calculations in CONTO are based on a rather conservative forecast of Russian economic development with average growth of GDP in 2013-2030 to be about 3.5% a year. The macroeconomic forecast corresponds with base scenario of pension system's development. Using variant of increased social contributions rates changes macroeconomic variables of the forecast.

With realization of base scenario real average pension in 2030 will be only 1.37 times higher than in 2012. GDP growth rates will be much higher – it will increase by 1.87 times. Thus, base scenario will make pensioners' living standards fall permanently. By 2030 ratio of average pension to average wage will decrease by 10 percentage points – to 25%. On the contrary, with scenario of increased rates real average pension will increase by 2.19 times by 2030.

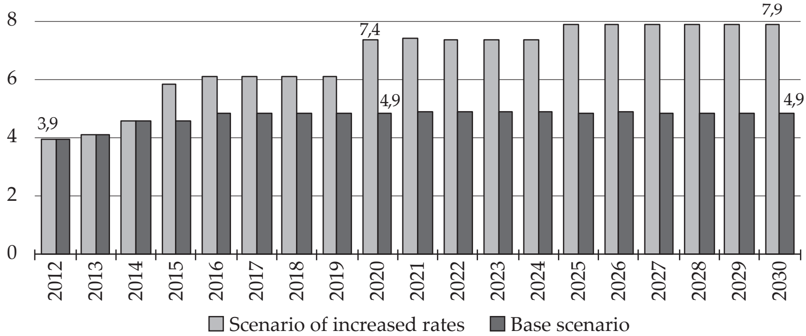
Figure 4 – Real average pension, 2012 = 1



Source: author's calculations.

However, it will require to raise pension expenditures by more than 4 percentage points of GDP in 2030 – they will be 11.8% of GDP. Accordingly, amount of social contributions will rise by 3 percentage points of GDP, and their efficient rate will rise by 12 percentage points. Amount of contributions for PAYG plan will be 7.9% instead of 3.9% of GDP in 2012.

Figure 5 – Social contributions for PAYG plan, % of GDP



Source: author's calculations.

Worthy of attention that GDP with realization of increased rates' scenario will by 1% higher than with base scenario in 2030. The result is explained by great multiplicative effect of pensioners' final consumption growth. There are a lot of goods mainly produced in Russia (for example, food) that have appreciable share in consumption structure of pensioners. Share of import in employees' consumption is higher. Consequently, financing of increasing rates by means of exchange of pensioners' and employees' consumption has some positive effect for GDP growth. Final household consumption in the scenario will be 7% higher than in the base one in 2030.

Simultaneously, because of increased rates are partly financed by profits of companies, reduction of fixed capital formation will be 7% in 2030. In whole, growth of pension expenditures will not destabilize macroeconomic situation in Russia for next twenty years.

Table 3 – Calculations' results

	Base scenario			Scenario of increased rates		
	2020	2025	2030	2020	2025	2030
GDP, 2012 = 1	1.49	1.68	1.87	1.50	1.69	1.89
Final households consumption, 2012 = 1	1.75	1.92	2.05	1.82	2.04	2.19
Fixed capital formation, 2012 = 1	1.80	2.14	2.51	1.75	2.07	2.44
Real average pension, 2012 = 1	1.18	1.28	1.37	1.66	1.95	2.19
Ratio of average pension to average wage, %	28.6	26.4	25.1	40.0	40.0	40.0
Pension expenditures, % of GDP	7.5	7.5	7.5	10.5	11.3	11.8
Social contributions for PAYG plan, % of GDP	4.9	4.9	4.9	7.4	7.9	7.9
Effective rate of social contributions*, %	27.4	27.4	27.5	37.3	39.4	39.5
Pension Fund of Russian Federation's budget deficit, % of GDP	2.4	2.5	2.4	2.9	3.2	3.8

*For all social security funds; includes contributions for PAYG plan.
Source: author's calculation.

Conclusions

For next decades Russian economy will have challenges from inevitable population ageing and its structural changes. One of such challenges is pension problems. Now ratio of population at retirement ages to population at working ages is 39%, but in 2030 it will be 59%. There is concern that because of unfavorable demographic situation supporting of acceptable pensioners' living standards will be rather hard. Really, by 2030 pension expenditures will be 11.8% instead of 7.4% of GDP today.

Growth of amount of pension benefits should be financed some way. Such steps as increase of retirement age or rise of government debt are very unlikely. Reserve of reduction of mandatory social contributions for funded plans is already almost exhausted, and outlooks of decrease of shadow economy's size are vague. Therefore increase of social contributions rates is very probable.

However, increase of the rates can affect economy in many different ways, for example through changes of amount and structure of final household consumption or through reduction of fixed capital formation. To take into account these interconnections a set of models was developed and linked. The set includes Russian pension system's model and interindustrial model of Russian economy. Calculations with the models demonstrate that for twenty coming years growth of pension expenditures will not decelerate economic development. At the same time structural changes of economy will be quite substantial.

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Analysis of South Africa's petroleum sector

Introduction

This paper is based on research conducted by Conningarth Economists in a project financed by the National Energy Regulator of South Africa (NERSA)[1]. The inputs of petroleum products play a very important part in transport and the production activities of various other sectors in the economy. South Africa is not well endowed with natural resources of crude oil and natural gas, which provides the basic feedstock for the production of petrol and other petroleum products. Consequently, it relies heavily on the importing of crude oil in order to feed its petroleum refineries.

South Africa is however, well endowed with coal resources, part of which is used in the coal-to-liquid process producing petrol, diesel and other petroleum products. Although the focus of the project was on the forecasting of the future demand for petroleum products, the implication for the demand/supply position, given the known refining capacity, is also touched upon.

The main focus of this paper is on the analysis and forecasting of the petroleum sector, by making use of the INFORUM modelling system, supported by other econometric instruments.

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[1] National Energy Regulator of South Africa (NERSA).

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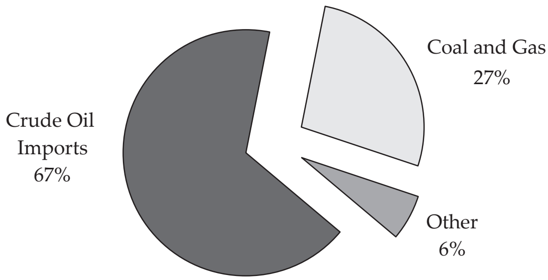
Supply perspective of the petroleum sector in South Africa

Due to the fact that South Africa does not have its own economically extractable natural crude oil resource, the domestic prices for petroleum products are mainly dependent on the world price of crude oil. The domestic petroleum price is based on import parity price (the cost to import petroleum products into South Africa). This import parity price is greatly dependent on the world price for crude oil, expressed in US$ and subsequently the Rand/US$ exchange rate.

Figure 1 depicts the composition of the main raw materials used in the production of petroleum products. Obviously, 67% of all petroleum products are crude oil based, whilst the bulk of the remainder use coal and natural gas. The volume of imports of refined petroleum products is relatively small and is limited to specialized products that local refineries cannot supply.

Figure 1 – Raw Material Sources for the Manufacturing of Petroleum Products

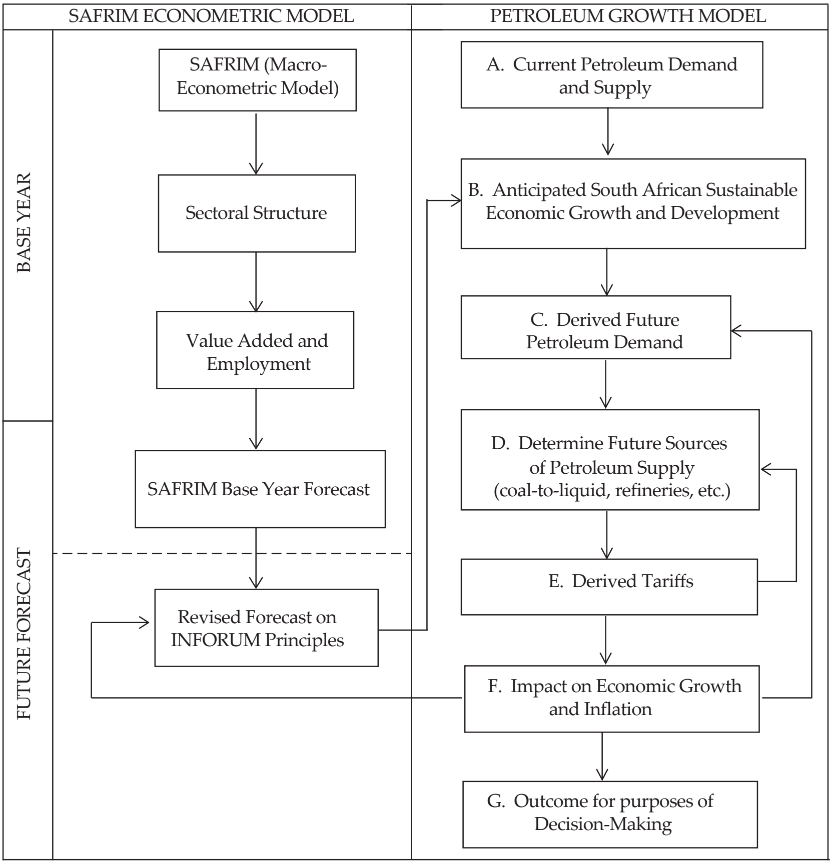


Linking the petroleum sector to the inter-industry macro-econometric model

The Inter-Industry Macro-Econometric Model (IM) was used as the main "driver" for the modelling system which must incorporate the petroleum sector. After selecting the INFORUM based macro-econometric model (renamed as SAFRIM – the South African Inter-Industry Macro-Econometric Model) as the main "driver" of the modelling system, the petroleum sector and its inter-relationships with the rest of the economy was modelled and linked to a macro model, named the Petroleum Growth model.

The SAFRIM Model was developed by Conningarth Economists, and assisted by ClopperAlmon of the University of Maryland in 2006. It is based on a standard INFORUM framework approach (Almon, 1991 and Grassini, 1998). By making use of Excel Spreadsheet analysis, the petroleum sector and its inter-relationships with the rest of the economy was modelled. With SAFRIM as the main driver of the PetroleumGrowth model and its linkages to the Excel Spreadsheet modelling system, a workable South African system is derived at (see Figure 2 below):

Figure 2 – SAFRIM Model linked to the Petroleum Growth Model



From this figure it can be deduced that the Petroleum Growth Model is driven by the outcome of the SAFRIM model and in particular the values of sectoral production.

Framework of the Petroleum Growth Model

The components (A to F), as per the Framework of the Petroleum Growth Model in Figure 2 above, are discussed below.

A. Current Petroleum Demand and Supply

The 2010 supply of and demand for petroleum constitutes the base year of the forecast of the demand and supply of petroleum (data source, SAPIA 2011). Petrol, diesel and other petroleum products were each modelled separately and then aggregated in order to derive the total petroleum demand. Petrol/production and diesel/production coefficients were used, developed by Conningarth Economists in order to derive demand for petrol, diesel and other petroleum products.

B. Anticipated South African Sustainable Economic Growth Development

The point of departure of the economic impact assessment model, to optimize petroleum supply and demand, is the current long-term forecast of the South African economy on a 46 sector base. The forecast is done by SAFRIM, combining the main features of key macro-models, i.e. they are macro-economic since they depict the behaviour of the economy as a whole, and produce projections for aggregated GDP and its components. They are multi-sectoral as they include Input-Output (I-O) accounting that shows intermediate consumption and they integrate intermediate input prices with sectoral price formation, reflecting the actual economy in a bottom-up approach.

C. Derived Future Petroleum Demand

The overall demand for petroleum products is linked to general economic performance (growth), how the sector growth is made-up, and the movement of prices of petroleum products relative to general prices and lastly technology changes in client industries. There is a close relationship between these three variables and the demand for petroleum products.

D. Determine Future Sources of Petroleum Supply

In modelling the petroleum requirements, two options were applied to increase capacity, namely an additional coal-to-liquid (CTL) plant, or to extend the capacity of the crude oil refineries. To maintain supply capacity at the desired level, there are three approaches to follow, firstly, import more refined products than the critical mass imports; secondly, expand existing crude oil refineries; and thirdly invest in coal-to-liquid (CTL) plants. The South African market notably demands more light products than the global market where the markets demand more of the heavier oils used, inter alia, in heating. The main drivers for the production of petroleum products are to provide petrol and diesel.

E. Derived Tariffs

Due to the fact that South Africa does not have its own economically extractable natural crude oil resources, the domestic prices for petroleum products are mainly dependent on the world price for crude oil. The domestic petroleum price is based on import parity (the cost to import petroleum products into South Africa). This import parity price is greatly dependent on the world price for crude oil, expressed in US Dollar and subsequently the Rand/US Dollar exchange rate. The pump price of petrol, diesel and paraffin are regulated, with various imposts added to the basic price, where the basic price excludes trade and transport margins and a whole array of fuel taxes.

Price plays an important part in the demand for all the petroleum products. To know the magnitude of the expected response of the consumer of petroleum products to a change in the prices it is confronted with, is important for forecasting purposes. This response can be quantified by dividing the change in quantity demanded into the price change that caused it and is called the price elasticity coefficient. These price elasticities or coefficients and prospective growth per sector will be the explanatory variables in petroleum demand functions that can be used to forecast petroleum demand.

F. Impact on Economic Growth and Inflation

The model serves as a complete dynamic inter-linked system. Changes in petroleum tariffs lead directly and indirectly to inflationary impacts which in turn have an effect on economic growth and development. Furthermore, a change in tariff leads to a change in direct demand of petroleum through the price elasticity of petroleum demand. The Petroleum Growth Model caters for these interactions by means of a process of convergence through iterations.

The model provides results on the impact of various scenarios regarding petroleum supply and demand.

Computer Software

The INFORUM model uses vary sophisticated programming software where some hand-coding in C++ is necessary. To render this system more user-friendly, the entire INFORUM based modelling system was translated into a user-friendly system, based on Excel spread sheets. The main purpose was to link the Petroleum Satellite Model with the macro-model. This user-friendly model is menu-driven and has various result tables to depict the impact of petroleum on economic and social indicators.

Economic growth projections and petroleum demand

The overall demand for petroleum products is linked to general economic performance, how the sector growth is made-up, and the movement of prices of petroleum products to general prices and lastly technology changes in client industries. The close relationship between these three variables and the demand for petroleum products must form the core elements of any demand function for forecasting purposes.

The demand for petrol and diesel represents the bulk of the total demand for petroleum products. To a large extent it determines the technical configuration of refineries. The focus is therefore on petrol and diesel production with other petroleum products making up the rest.

Table 1 – Demand Trends of Petroleum from 1988 to 2009

	Average Annual Growth Percentage from 1988 to 1999 (1998 base year)	Average Annual Growth Percentage from 1999 to 2009 (1999 base year)
Petrol	2.40%	0.40%
Diesel	0.90%	4.30%
Other Petroleum	2.70%	1.40%

It is evident from Table 1 that the demand for petrol grew much faster than that of diesel in the first period (1988-1999). However, this phenomenon has changed drastically in the period 1999-2009 where diesel grew at 4.3% pa and petrol only at 0.4% pa. A number of factors contributed to this development one being the historic situation where diesel had been in a surplus supply position (due to refineries being set up to supply the strong petrol demand) which was also reflected in a lower price relative to petrol. This encouraged the introduction of diesel powered passenger vehicles also coupled with their much better consumption performance *vis-à-vis* petrol driven vehicles.

The SAFRIM model captures the integrated nature of the South African economy in terms of the linkages that occur between economic sectors and households throughout the national economy. Furthermore, the model also captures the linkages that exist between the South African national economy and its international trading partners by incorporating imports and exports into the model. As such, the forecasts produced by the SAFRIM model are based on macro-economic data that provides a broad and high level of perspective on the national economy.

The results of the projection indicate that the most likely long-term GDP growth rate from 2012 to 2020 will be in the order of 4.0% per annum. This growth rate is very much in line with a growth of 3.6% p.a. which was obtained over the last decade (data source, SARB). The main final demand "drivers" of this outcome are shown in the table below.

The exports are mostly derived from a bottom up research approach where government expenditure was based on an assumption. The other components form an integrated/endogenous part of the modelling system. Key economic "drivers" such as population growth, government expenditure, global economic trends and international trade, were also applied (South Africa being regarded as the Gateway to Africa).

Table 2 – Estimating Long-Term Economic Growth for Final Demand Components and Gross Domestic Product

	GDP Growth Rate per annum		
	2012-2020	2012-2015	2016-2020
Final Consumption Expenditure by Households	4.00%	4.00%	3.80%
Final Consumption Expenditure by Government	4.30%	4.80%	3.90%
Gross Capital Formation	5.10%	4.50%	5.20%
Exports of Goods and Services	3.20%	3.00%	3.40%
Imports of Goods and Services	4.30%	4.40%	4.20%
Total Real Gross Domestic Product	4.00%	3.70%	3.90%

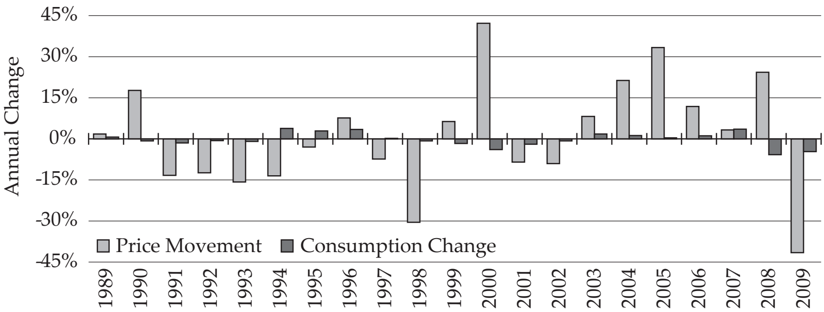
Note: Growth in 2010 is included in the above projections.

Price elasticity of the demand for petroleum products

Price plays an important part in the demand for all the petroleum products. To know the magnitude of the expected response of the consumer of petroleum products to a change in the prices it is confronted with, is important for forecasting purposes. This response can be quantified by dividing the change in quantity demanded into the price change that caused it and is called the price elasticity coefficient.

These price elasticities or coefficients and prospective growth per sector are the explanatory variables in simulatory petroleum demand functions that are used to forecast the demand. These petroleum demand functions lend themselves to the interactive and circular process when used for forecasting. An increase in the petroleum product price have an effect on petroleum demand, that affects investment in refineries and pipelines required, that in turn feeds back to petroleum prices and again affects demand for the petroleum products until the effect converges in the forecast demand.

Figure 3 – Crude Oil Price and Consumption Effect over the Short-Term



Note: Excludes long term changes.

From the figure above it is clear that responses of consumption to price changes are not significant over the short-term. Over the long-term, relative price changes of crude oil will however not leave the consumption of petroleum products unaffected.

Estimation of functional relationships for petroleum products

The demand forecasts for petroleum products were done separately for petrol, diesel and other products, and then added together to make up the total demand for petroleum products. The reasoning behind this is that the demand for each of the individual petroleum components originates from different sets of intermediate sectors and final demand entities where the price elasticities and technology content for each of these products also differ.

For instance, petrol is still used more by households for private transport than diesel. Industries are more diesel orientated for energy inputs in their production processes as is the land freight transport sector. Furthermore, historical analysis showed that the demand for petrol is more price sensitive than for example diesel.

In the demand forecasts, two scenarios were developed namely; a standard scenario and a high petroleum price scenario. The future price changes of crude oil, where crude oil is a determinant factor on the price of petroleum, will have a crucial effect on the demand for petroleum products. It is therefore important that the price changes in the crude oil price should be monitored carefully from time to time and the demand forecast of petroleum adjusted accordingly. It is important to note that for both scenarios the specific view has been taken on the rise of the petrol price as well as the production price index (PPI). Price elasticity is not based on the nominal price of petroleum but on the relative price, therefore it is also necessary that the view must be taken on the average inflation proxy by the PPI.

Methodology

The structure of the three demand functions to be used for forecasting the demands of the various petroleum products are similar. In essence, three variables are used to explain the demand movements over time. The first variable explains how the demand for a particular petroleum product is actually dependent on the growth of the economy in general as well as of those sectors that are the main off-takers of the particular product. The second explanatory variable will reflect in quantitative terms how relative price changes (price elasticity) will affect the demand of the specific petroleum product. The change in technology and the effect thereof on demand (in terms of for example more fuel efficient cars) is also included in the demand function as a third variable.

For each of the petroleum products (petrol, diesel and other fuels), a multiple regression model was developed, to explain the relationship between changes of petroleum product prices from 1988 to 2009, in order to predict prices for the next 15 years.

A specific main variable addressed above, called calculated demand indicator was designed to present the historic domestic demand for the various petroleum products when price elasticity and technology changes are not taken into account. This variable was calculated for the 46 economic sectors and for households, and it captures the growth in the economy and the change in the structure of the economy. This variable was compiled from the output of the various sectors of the economy and by making use of petroleum input coefficients for each of the sectors as well as households. For instance, the agriculture sector uses much more diesel than petrol. The opposite is true for household consumption where private cars mostly use petrol.

Relative prices were used to calculate a variable to reflect price sensitivity (demand elasticity) in the regression analysis. The relative price of petrol was calculated by means of an index for each component by using each of the petroleum products' pump price obtained from the South African Petroleum Industry Association (SAPIA) with 2005 as base year and the Producer Price Index (PPI), which was obtained from the South African Reserve Bank bulletin. By dividing the two indices, the relative price index for each of the petroleum products was obtained. The actual domestic petroleum demand variables are from SAPIA and the petroleum usage indicators were calculated using the production values per economic sector (46 sectors) in constant terms and the petroleum coefficients for each of the various sectors and households.

Time was used in the regression analysis as a variable to explain the change in technology over time which affects the usage of a specific petroleum product.

Petrol

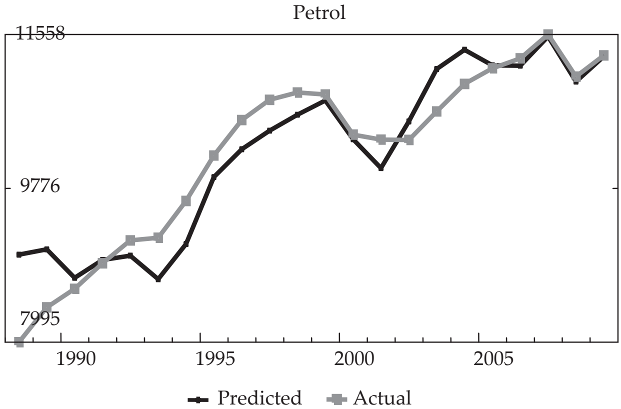
In the petrol regression, the dependent variable is the actual volume of petrol demand with explanatory variables as the calculated petrol demand indicator, the relative prices for petrol and relative prices for petrol lagged one period. The regression period is from 1988 to 2009.

RBSQ		0.8503	
Dependent variable: Actual Domestic Petrol Demand			
	Reg-Coef	Elas	t-value
Intercept	8,440.93	0.93	17.93
Calculated Petrol Demand Indicator	1.05	0.82	8.29
Petrol Relative Prices	-5,030.76	-0.24	-2.52
Petrol Relative Prices (1)	-3,024.76	-0.41	-3.71

From the table above it is evident that there is a statistically significant relationship between the exogenous variables (calculated petrol indicator and relative petrol prices) and the endogenous or dependent variable i.e. domestic petrol demand. The positive coefficient on the intercept and the calculated petrol demand indicator is in line with economic theory. A negative relationship between relative petrol price and actual domestic petrol demand was expected and the regression results confirm that. The significant influence of the lagged relative petrol price explains that the increase in the petrol price has an immediate as well as a delayed effect on the demand for petrol. The petrol usage indicator, the relative petrol price and lagged relative petrol price are all statistically significant with t-values of more than 2 for all parameters. The adjusted R^2 (RBSQ) indicates that the equation explains almost 85% of the variation of the demand for domestic petrol, which is a significant fit.

The figure below portrays how well the regression equation estimates the actual path of the demand for petrol which makes it suitable for forecasting purposes.

Figure 4 – Comparison of Actual and Estimated Demand for Petrol



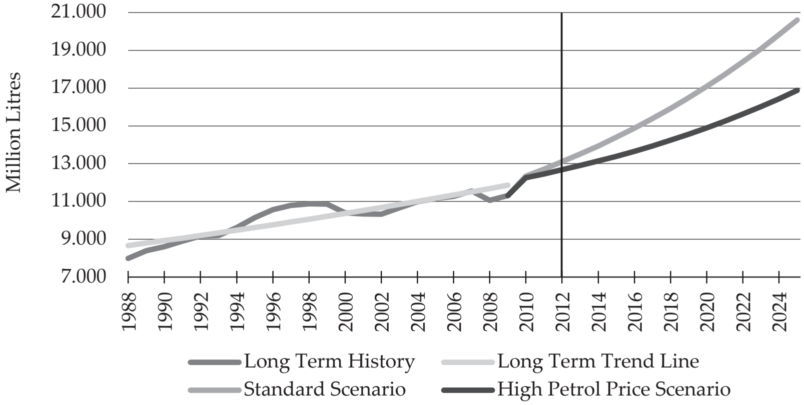
It is important to note that technology improvement represented by the time variable was also tested but it was not statistically significant and therefore ignored.

The following figure depicts the historical and projected growth of petrol demand. The assumptions on the growth rates over the projection period of the two relevant prices determining the relative price change indicator are:

- Petrol price 8% pa; and
- Producer Price Index (PPI) 6% pa.

For purposes of the high petroleum price scenario, it was assumed that the petrol price will grow at a higher rate of 10% than the assumed 8% for the standard scenario.

Figure 5 – Historical and projected growth rates of demand for petrol in South Africa (1988-2025)



Historic growth: 1.5% pa   Projected standard scenario: 3.8% pa
High Petroleum Price Scenario: 2.5% pa

Source: Conningarth Economists.

Standard Scenario

The estimated growth rate of the domestic demand for petrol in the standard scenario is around 3.8% per annum, which is double the historic rate of 1.5% per annum. This projected result of the increased demand in petrol is assumed to be as a result of more and more people buying cars as wealth increases. Therefore petrol demand, specifically if the price of petrol does not increase rapidly beyond general expectations, will follow this trend. The rather low historic growth rate in petrol demand is the result of a relative high increase in petrol prices over this period.

High Petroleum Price Scenario

The lower growth in petrol demand due to the price effect is properly illustrated by the High Petrol Price Scenario where the forecast for petrol drops from 3.8% per annum to 2.5% pa if the petrol price changes drastically when the assumption for the increase in the petrol price per annum changes from 8% to 10%.

Diesel

The result of the diesel regression analysis over the same time period as for petrol is given in the table below.

RBSQ		0.9575	
Dependent variable: Actual Petrol Demand			
	Reg-Coef	Elas	t-value
Intercept	1,294.62	0.20	3.00
Calculated Diesel Demand Indicator	0.98	0.94	3.85
Time	-72.85	-0.33	-1.38
Diesel Relative Prices	1,630.55	0.19	2.03

The results suggest a positive intercept and a positive relationship with the calculated petrol demand indicator - which was to be expected and corresponds with practical experience and theory. There is also a positive relationship between diesel demand and the relative diesel price. This is quite an interesting result which point to the fact that at this point in time diesel consumption is somewhat "immune" to price variations probably because of the fact that diesel engines are markedly more efficient and economical than petrol engines. However this gap is closing steadily. It should also be kept in mind that diesel prices are regulated as is the petrol price, although the former is somewhat less regulated. For purposes of this scenario, which depicts the demand for diesel under the assumption of a higher increase in diesel price, it was also assumed that in future, the price elasticity for diesel will be much more in line with that of petrol.

The time variable used in this regression came out negative suggesting that diesel demand will still increase at a slower pace over time because it is becoming even more efficient per kilometre travelled due to technological advances. The adjusted R^2 (RBSQ) indicates that almost 96% of diesel consumption is explained by the diesel demand indicator, time and relative diesel prices. The t-stat for all variables is statistically significant except the one for time.

The figure 6 reconfirms the very good fit between the actual and the estimated demand.

The figure 7 depicts the historical and projected growth for diesel demand. The assumptions on the future movement of the two prices used to calculate the relative price change indicator are:

- Diesel price 8% pa; and
- Producer Price Index (PPI) 6% pa.

For purposes of the high petroleum price scenario, it was assumed that the diesel price will grow at a higher rate of 10% than the assumed 8% for the standard scenario.

Figure 6 – Comparison of Actual and Estimated Demand for Diesel

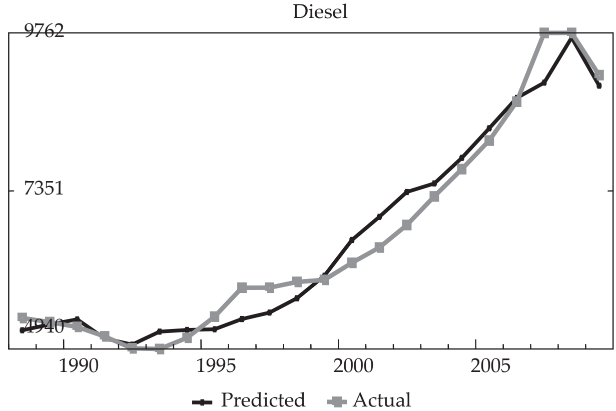
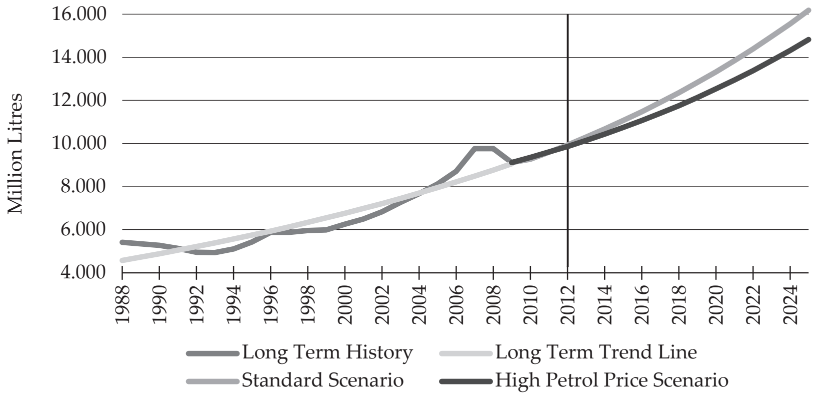


Figure 7 – Historical and projected demand for diesel (2009-2025)



Historic growth: 3.3% pa   Standard scenario: 3.7% pa
High Petroleum Price Scenario: 3.1% pa

Standard Scenario

The historic growth rate for diesel sales was 3.3% per annum and the projected growth rate is 3.7% per annum. The future growth in diesel demand will closely resemble the growth in the transport sector, which is forecasted as 2.9%.

High Petroleum Price Scenario:

The lower growth in diesel demand due to the price effect is nicely illustrated by the High Petroleum Price Scenario where the forecast for diesel drops from 3.7% per annum to 3.1% pa if the diesel price changes drastically when the assumption for the increase in the diesel price per annum changes from 8% to 10%.

Conclusion

The South African Forecasting Inter-Industry Model (SAFRIM) as well as the additional modelling that was done outside SAFRIM, performed satisfactory and the results were on par with economic theory. It performed very well in terms of the forecasting of the South African Economy and responded in an acceptable manner in accordance with changes in exogenous variables. It was not that rigid (big changes in exogenous variables to obtain small changes in results) which is sometimes the case with standard econometric models being dependent on lagged variables. It could therefore be deduced that it can be used for forecasting purposes as well as macroeconomic impact analysis. It also proved that it could be used in combination with other input-output applications.

However, it is important to note that the whole petroleum application could undertake an INFORUM approach. This refers to the INFORUM theoretical approach as well as the INFORUM software. Currently the analysis was done through the INFORUM software in conjunction with the Excel Spreadsheet programme. To make the modelling system more dynamic as well as user friendly it is probably necessary to include the whole programming system as part of SAFRIM, supported by the INFORUM software.

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M. Plich

Determinants of modeling the impact of possible shale gas extraction in Poland

Introduction

Natural gas currently meets close to one-fourth of the total energy needs of the world and EU economies. There are at least two major reasons authorizing the conclusion that the twenty-first century can be the age of gas. First, the results of worldwide research shows the huge potential of so called unconventional gas[1] resources, which increases the current proven reserves of natural gas by almost twice. Secondly, in recent years there has been tremendous progress in the techniques of extracting gas from unconventional resources, particularly those from shales.

Techniques of production of gas form unconventional resources was developed in the U.S. since the early 80-ies of XX century, and has been improved to such an extent that in the last 10 years completely changed the gas market in North America. The experience of the U.S. drew attention to the unconventional natural gas deposits in the world. It turns out that they are so rich that they give hope to postpone the energy problems of a dozen or even dozens of years. An additional advantage is that the unconventional resources are present on all continents and are distributed fairly evenly between the regions. Poland is also mentioned among the countries with significant deposits of unconventional gas. This information has awakened hopes in Poland to improve the country's energy security.

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[1] Resources are treated as "unconventional" if they require greater than industry-standard levels of technology or investment to harvest (see www.adv-res.com - web page of Advanced Resource International Inc.)

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There are many indications that the Polish unconventional gas resources may have significant importance for national and even European balance of energy. If these predictions were confirmed, unconventional gas would open up new opportunities for Poland. They result from reducing or even stopping the import of natural gas and increasing its share in the energy balance of the country at the expense of coal. This would contribute significantly to the Polish energy security and reduce greenhouse gas emissions. If the most optimistic forecasts were true, Poland could become a major supplier of natural gas to the EU market. Independence from imported gas and gas export potential would be a significant enhancement for the Polish economy. Currently the public debate about the exploitation of shale gas in Poland is dominated by optimistic approach, suggesting that this new resource will ensure Poland's energy independence, high economic growth and additional jobs.

However, the possible exploitation of unconventional deposits also raises new challenges. They are associated with risks to the environment and the society, resulting from the specific methods of extraction of unconventional gas. In the economic literature considerations can be found indicating the existence of other negative effects of large scale exploitation of natural resources, referred to as "natural resource curse". It is therefore necessary to consider these risks and – if possible – to confront them with potential benefits.

It is almost sure that the shale gas deposits exploitation in Poland will start in the next 10 years. This prospect raises the need to undertake a closer examination of the effects of these new activities. In these circumstances the quantification of costs and benefits resulting from possible exploitation of unconventional gas in Poland is an interesting but difficult task of research. This task is included as a part of the project titled *The prospect of exploitation of shale gas deposits in Poland in light of the "resource curse" concept*. The project is funded by the Polish National Science Center and carried out at the Institute of Econometrics in collaboration with the Chair of International Trade of the University of Lodz. The analyses will be conduct using IMPEC model – a macroeconomic multisectoral model of the Polish economy.

This article is intended to present main determinants of the future production of shale gas in Poland in the European and global context, and in the light of the news about deposits of shale gas in the world as well as possibilities of their exploitation. It concentrates on the new opportunities which are opening for the Polish economy in connection with the shale gas resources (second paragraph), on the one hand, and identifies risks and uncertainties associated with its exploitation, like the actual magnitude of resources or the environmental threats on the other (third paragraph). The paper provides a background for modeling of the impact of possible shale gas extraction in Poland, using model IMPEC, in particular:

- formulates scenarios for long term simulations to assess the impact of the new sector (production of shale gas), on the Polish economy (fourth paragraph),
- identifies economic mechanisms of influence of shale gas extraction on the Polish economy and indicates the main directions of development of the IMPEC, to take account of the new sector (fourth paragraph).

Unconventional gas resources and opportunities for their exploitation

Report on unconventional gas resources

Usually three types of unconventional gas deposits are distinguished:

- shale gas[2] (gas in rocks of clay-mud),
- tight (gas in reservoirs/deposits of low permeability),
- coal bed methane.

These natural gas resources were historically overlooked in search of more economical, conventional reserves. Also hydrates located in the oceans contains huge amounts of natural gas, but there are no effective techniques of their exploitation.

In April 2011the US Energy Information Agency[3] (EIA) published a report on world shale gas resources prepared by Advanced Resources Agency Inc.[4] (ARI) – see EIA 2011. If the resource estimates from this report were confirmed, it would mean almost doubling gas reserves in the world. This could cause serious changes on the regional gas markets. Interested in this turn of events are especially those countries that are forced to import large quantities of fossil fuels and primarily natural gas, due to lack of own deposits. Table 1 it contains estimated shale gas resources for selected basins in 32 countries according to the EIA/ARI study.

The numbers show technically recoverable reserves. These values are compared with proved reserves, production and consumption during 2009. Last columns contains information on «sufficiency» of the reserves by country. Sufficiency shows the ratio of reserves to the amount of consumption (for importers) or production (for exporters). It shows for how many year the demand for consumption or production can be satisfied of these reserves (ceteris paribus).

[2] Shale is a sedimentary rock rich in organic material that is found in many parts of the world.
[3] Energy Information Administration is the statistical and analytical agency within the U.S. Department of Energy.
[4] Advanced Resources International (ARI) is a research and consulting firm providing services related to unconventional gas (coalbed methane – CBM, gas shales, tight sands), enhanced oil recovery (EOR), and carbon sequestration (CO2 sequestration).

Table 1 – Estimated shale gas technically recoverable resources for selected basins in 32 countries, compared to existing reported reserves, production and consumption during 2009, sufficiency of reserves

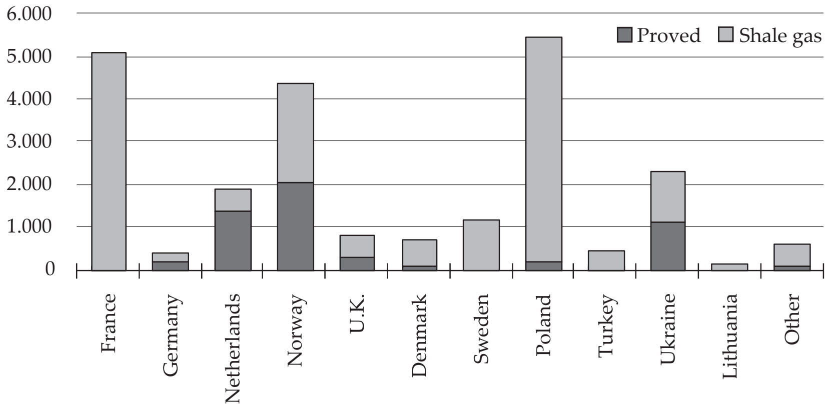
		2009 Natural Gas Market			Proved NG Reserves (Rc)	Technically Recoverable Shale Gas Resources (Ru)		Sufficiency of reserves (ceteris paribus)			
		Production (P)	Consum-ption (C)	(C-P)/C				Exporters (years of production)		Importers (years of consumption)	
		Bcm	Bcm	%	Bcm	Bcm	% of total	Rc/P	(Rc+Ru) /P	Rc/C	(Rc+Ru) /C
Europe	France	0,0	49,0	98%	0	5.097	2,7%	-	-	0	104
	Germany	14,4	92,6	84%	176	227	0,1%	-	-	2	4
	Netherlands	79,0	48,7	-62%	1.388	481	0,3%	18	24	-	-
	Norway	103,4	4,5	-2156%	2.039	2.350	1,3%	20	42	-	-
	U.K.	59,2	88,1	33%	255	566	0,3%	-	-	3	9
	Denmark	8,5	4,5	-91%	59	651	0,3%	7	84	-	-
	Sweden	0,0	1,1	100%	0	1.161	0,6%	-	-	0	1025
	Poland	5,9	16,4	64%	164	5.295	2,8%	-	-	10	332
	Turkey	0,8	35,1	98%	6	425	0,2%	-	-	0	12
	Ukraine	20,4	44,2	54%	1.104	1.189	0,6%	-	-	25	52
	Lithuania	0,0	2,8	100%	0	113	0,1%	-	-	0	40
	Other	13,6	26,9	50%	77	538	0,3%	-	-	3	23
North America	US	583,3	645,6	10%	7.716	24.409	13,0%	-	-	12	50
	Canada	159,4	85,2	-87%	1.756	10.987	5,9%	11	80	-	-
	Mexico	50,1	60,9	18%	340	19.284	10,3%	-	-	6	322
Asia	China	83,0	87,2	5%	3.030	36.104	19,3%	-	-	35	449
	India	40,5	53,0	24%	1.073	1.784	1,0%	-	-	20	54
	Pakistan	38,5	38,5	0,0	841	1.444	0,8%	-	-	-	-
Australia		47,3	30,9	-52%	3.115	11.213	6,0%	66	303	-	-
Africa	South Arfrica	2,0	5,4	63%	0	13.734	7,3%	-	-	0	2553
	Libya	15,9	5,9	-165%	1.549	8.212	4,4%	98	616	-	-
	Tunisia	3,7	4,8	26%	65	510	0,3%	-	-	14	119
	Algeria	81,6	28,9	-183%	4.502	6.541	3,5%	55	135	-	-
	Morocco	0,0	0,6	90%	3	311	0,2%	-	-	5	555
	Western Sahara	0,0	0,0	0,0	0	198	0,1%	-	-	-	-
	Mauritania	0,0	0,0	0,0	28	0	0,0%	-	-	-	-
South America	Venezuela	18,4	20,1	9%	5.066	311	0,2%	-	-	252	267
	Colombia	10,5	8,8	-21%	113	538	0,3%	11	62	-	-
	Argentina	41,3	43,0	4%	379	21.917	11,7%	-	-	9	518
	Brazil	10,2	18,7	45%	365	6.400	3,4%	-	-	20	362
	Chile	1,4	2,8	52%	99	1.812	1,0%	-	-	35	675
	Uruguay	0,0	0,0		0	595	0,3%	-	-	-	-
	Paraguay	0,0	0,0		0	1.756	0,9%	-	-	-	-
	Bolivia	12,7	2,8	-346%	750	1.359	0,7%	59	166	-	-
Total of the above areas		1.503,6	1.557,4	-3%	28.345	**187.514**	100,0%	19	144	-	-
TOTAL WORLD		3.015,7	3.021,4	0%	**187.146**			-	-	62	62

Source: EIA 2011 and own calculations.

The data in Table 1 show that proved gas reserves amount to 187.1 tcm. The total amount of shale gas for the surveyed countries is 187.5 tcm. This means that if shale gas estimates are confirmed, the world reserves of gas will double. In such a case, potential of energy resources of some countries will rise very much. The biggest winners are China, Canada, Argentina and Mexico. These countries shares of estimates of shale gas resources exceeds 10%.

Figure 1 shows reserves of gas in Europe showing both proved and shale gas reserves. Poland seems to be the biggest winner in Europe with deposits of shale gas amounting to over 5 tcm. Estimates for France are at the similar level. The size of these deposits can be seen by comparing it with conventional gas deposits in Norway, which is important exporter of natural gas in Europe. Estimates of shale gas resources in Poland are more than twice as high as conventional gas resources in Norway.

Figure 1 – Reserves of gas in Europe



Source: Author's elaboration based on EIA 2011.

To show the potential of deposits of natural gas, in Table 2 another list of world's gas resources is presented. Here, contrary to the Table 1, not proved but technically recoverable resources of conventional gas is shown. They amount to 421 tcm which is much higher than the proved reserves in table 3 which amount to 187 tcm. Also the magnitude of shale gas presented in Table 2 is higher. This is because in Table 1 estimates only for countries with the biggest shale gas potential are shown. Also sizes of deposits of other unconventional gas are presented in Table 2. They are not so impressive as in case of shale gas. Reserves of tight gas and coalbed methane taken together represent half of the shale gas resource estimates.

Table 2 – Remaining technically recoverable resources by type and region, end 2011 (tcm)

	Total	Conven-tional	Unconventional				Unconv. share (%)
				Tight	Shale	Coalbed	
E. Europe/Eurasia	174	131	43	10	12	20	24,7
Middle East	137	125	12	8	4	-	8,8
Asia/Pacific	128	35	93	20	57	16	72,7
OECD Americas	122	45	77	12	56	9	63,1
Africa	74	37	37	7	30	0	50,0
Latin America	71	23	48	15	33	-	67,6
OECD Europe	45	24	21	3	16	2	46,7
World	752	421	331	76	208	47	44,0

Source: IEA 2012.

The amounts referred to in the ARI report should not be treated as the verified and final. There are no studies giving such an ability. However, in contrast to other reports, carrying out a study on all regions of the world, according to a unified methodology allows for a relative comparison of prospective basins on every continent, though certainly the amounts of deposits will be verified in the future (IK 2011: 32).

Methods of extraction of shale gas

The existence of rich gas resources in shales was known as early as the first half of the nineteenth century. In the past, attempts have even been made for its use, but the ease of access to conventional resources and their abundance, has discouraged to improve the techniques of extraction of shale gas. There are several fundamental differences between conventional gas deposits, and those in the shales, causing these difficulties in extracting shale gas:

- large depth of shale gas deposits (1.000-5.000 m) causing the need for drilling of very deep wells, which is the essential cost in the stage of preparation of production,
- low efficiency of classical (vertical) wells, due to,
- lower density of gas in a unit volume of deposits,
- poor porosity of shales, causing weak release of gas from shales.

This is why shales was of little use as a source of gas until about a decade ago, when American companies developed new techniques of releasing shale gas by fracturing of shales and drilling horizontally.

A breakthrough in shale gas exploitation took place in the 1970s and 1980s as a result of the following circumstances:

- an increase in demand for gas in the world and the U.S., due to its numerous advantages, which was mentioned above,
- depletion of conventional gas resources in the U.S., resulting in the need for more expensive gas imports,
- incentives for technology research exploitation of unconventional sources of gas made in the USA in 1980,
- steady increase in gas prices, which are indexed to oil prices.

Risks associated with production of shale gas

Risks associated with shale gas extraction can be considered at several dimensions. First, business risk, ie the risks associated with the viability of the development of shale gas production. Second, risks associated with the adverse impact of the shale gas production on natural environment and society. Third, risks referred to as 'natural resource curse' in the literature. There is also a political risk, because countries whose economies depend strongly on exports of fossil fuels may oppose (in different ways) the exploration and extraction of shale gas in some regions.

Business risks

Exploitation of less and less accessible gas fields increases production costs and the uncertainty of success. The uncertainty results from many factors, like geological structures, social, economic as well as institutional environment. The key factors determining successful shale gas development, are the following (IEA 2012, 2011):

- resource size, structure and technical accessibility,
- access to resources (access to geological data and no physical, social or environmental constraints),
- the fiscal and regulatory framework (overall conditions for investments)
- availability of expertise and technology (experienced workforce and well equipped service sector),
- existing infrastructure – gas transport and guaranteed access to it,
- market and pricing – reliable, proximity to market,
- water availability.

Risk of adverse impact on environment

Shale gas exploration involves interference with the natural environment, such as drilling, making perforations in the well casing and hydraulic fracturing. This stage as well as stage of gas transport, cause threats for the environment. Most of the threats are common for conventional and shale gas. This include transport and some aspects of drilling and completion of wells. The common risk are emissions. Production and transport of natural gas (regardless of source) entails the environmental effects which for oil and coal do not occur, or occur with much less force. It mainly concerns leakages of methane along the gas value chain. Methane is the main component of natural gas and one of greenhouse gases. The leakages are caused by:

- intentional venting,
- fugitive emissions (leaks in pipelines, valves, seals),
- incidents (ex. rupture),
- incomplete burning (max effectiveness is 98%).

Shale gas extraction has some distinctive features and requirements when compared with conventional gas which are not without impact on the environment

- excessive water use (one fracturing needs 5-20 thousands of cubic meters), and necessity of waste water disposal, which are much higher than in case of conventional gas,
- risk of water contamination (surface water and aquifers): accidental spills of fluids or solids, leakage of fracturing fluids, leakage of hydrocarbons or chemicals form production zone, discharge of insufficient treated waste water into groundwater or deep underground,
- higher risk of environmental damage of drilling and production activities – wells are usually much deeper and more wells must be drilled for extraction the same amount of gas because average efficiency of one well is lower,
- higher density of wells at an area – conventional fields might require less than one well per ten square kilometers, unconventional fields might need more than one well per square kilometer conventional gas less concentration in the area,
- greater energy use during well drilling and completion,
- greater risk of earthquakes (connected with drilling and fracturing),
- more noise from drilling and transport,

- adverse social impacts – areas with strong unconventional potential are not always those with strong tradition of oil and gas industry activity, which tends to cause a problem of public acceptance,
- more space used for one well (pool for fracturing fluid, and for waste water after fracturing, the greater the amount of equipment used).

Risk of resource curse

Currently the public debate about the exploitation of shale gas in Poland is dominated by optimistic approach, suggesting that this new resource will ensure Poland's energy independence, high economic growth and additional jobs. In the economic literature considerations can also be found indicating the existence of negative effects of large scale exploitation of natural resources, referred to as «resource curse».

The resource curse is a concept that is of high interest to economists since the mid-1990s. Although negative effects of abundance of natural resources has been observed earlier (see eg. Gelb, 1988), in particular the paper by Sachs & Warner (1995) was a contribution to further discussion. The authors drew attention to the negative correlation between the abundance of resources and economic growth and created an econometric model, which to this day refer to almost all authors studying the relationship between abundance of natural resources and economic development. Below are listed the most important phenomena associated with the resource curse:

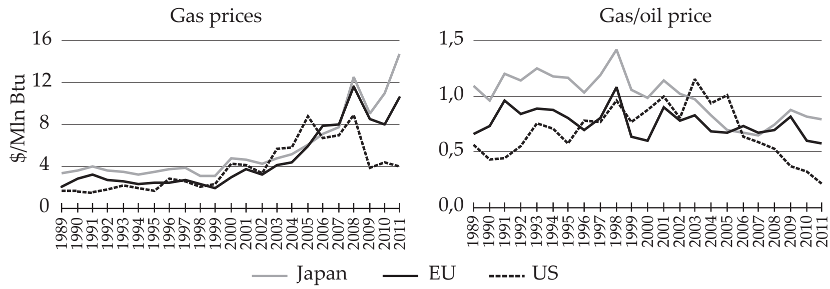
- Dutch disease, manifesting in the appreciation of the real exchange rate reduces the competitiveness of exporters of goods originating in the country (Sachs & Warner 1995; Gylfason *et al.* 1999, e.g. Giesecke *et al.* 2007).
- Price volatility and demand volatility of raw materials on international markets leading to a lack of macroeconomic stability (Manzano & Rigobon 2001, Humphreys et al. 2007, Mai *et al.* 2010).
- Nuisance to local communities (decreased quality of life associated with the extraction, forced migration, unattractive work opportunities, environmental degradation) (Collier & Hoeffler 1998).
- other phenomena related mainly to weak institutions and week democracy, like danger of corruption, unequal access to knowledge and unequal bargaining power of groups of stakeholders, a false sense of security leading to over-consumption and under-investment (especially insufficient investment in education and reforms).

Although it appears that some of these factors do not exist in the case of Poland, it must be remembered that the quality of Polish institutions, the level of corruption index, the treatment of the obligation to conduct public consultations and the level of social mobilization in Poland differ from the standards of highly developed countries. It can be assumed that if shale gas – the raw material of strategic importance – is exploited on a large scale, at least some of the risks associated with the concept of the resource curse may materialize in Poland.

Political risk

The increase in the gas supply can result in detachment of gas prices from oil prices and consequently a slower rate of increase in gas prices, and even their decline. The example of U.S. proves that it is a real possibility (see Figure 2). In recent years, due to the increase in the supply, prices of natural gas in U.S. have fallen by half. The decline in relation to the price of oil is even stronger, because in 2011 prices of gas were five times lower in comparison with the year 2003.

Figure 2 – Prices of gas and gas/oil prices in Japan, EU and US



Source: Author's elaboration based on BP 2012.

Changes in the gas market in the U.S. have an impact on the markets in other regions of the world. United States decreased imports of LNG (the main supplier was Qatar) and began using its terminals to export gas. As a result of surplus in supply, LNG prices have fallen in the world. Dissemination of shale gas extraction methods, which until now were the domain of the U.S. can be a stimulus to the profound changes in other markets.

The transfer of experiences of extraction of shale gas to the European market could reduce Europe's dependence on Russian natural gas. "Now American companies are looking abroad for lucrative shale fields in countries hungry for more energy. They are focusing particularly on Europe, where gas prices are sometimes twice what they are in the United States, and large shale beds are located close to some cities". (Krauss 2009). The realization of these plans can also lead to a situation where new investments in trans-European gas pipelines such as Nord Stream and South

Stream, will prove to be economically unviable. This in turn can lead to a decline in the importance of Russia as a major supplier of gas to European markets. In this context, one should also pay attention to China, which have large reserves of unconventional gas. Starting the exploitation by China could lead to the cessation of imports from Russia and even begin exporting energy, which would change the Asian balance of energy.

Within the EU approach to these new capabilities is not clear. The Polish government strongly supports the exploration of shale gas. The activities in this direction are taken also by Great Britain while France and Bulgaria introduced a ban on hydraulic fracturing.

Prospects of shale gas development

The rapid growth of shale gas production in the U.S. since the start of the previous decade and optimistic reports on the resources of unconventional gas deposits, especially in shales, caused the emergence of research analyzing possible changes in the energy markets due to the possibility of increasing the supply of gas. The examples are reports of International Energy Agency covering the whole world (IEA 2011 and 2012), report by Joint Research Centre of European Commission concerning EU (EC JRC 2012) as well as studies relating to Poland, done by Polish institutions (IK 2012, CASE 2012, Moncarz & Poreba 2012). In this chapter we present projections of the energy market in the world up to 2035 by International Energy Agency, as a background for discussion of the scenarios for Poland.

Scenarios for the gas markets

Every year International Energy Agency releases World Energy Outlooks containing the newest data and comments on global and regional energy markets. Under the same series the Agency releases special reports with analysis of strategic issues that will shape the energy future. In 2011 a special report on unconventional gas perspectives was issued under the telling title *Are we Entering a Golden Age of Gas?* (IEA 2011). The report foresees a tripling in the supply of unconventional gas between 2010 and 2035, leading to a slower price rise than would otherwise be expected.

Fast growth of gas production from unconventional sources, however, cause concerns about risk of larger environmental footprint than in case of conventional gas. This issue has given rise to another report by the IEA, also under the meaningful title “Golden Rules for a Golden Age of Gas” (IEA 2012). It presents arguments in favor of the thesis that the danger associated with larger environmental footprint can be eliminated by the use of the relevant rules of conduct, referred to by the authors as the “Golden Rules” (see Table 3).

Table 3 – Golden Rules of IEA forecast

The rules	Description
Measure and disclose	Operational data on water use, fracturing fluid additives, waste water and air emissions and engage of local community and other stakeholders into each phase of a development provide sufficient opportunity for comment on plans.
Watch where you drill	Choose the well sites to minimise impact on a local community, properly survey geology of the area to before making the decision on drilling and farcturing, monitor to ensure that the fractures do not extend beyond gas-producing formation.
Isolate wells and prevent leaks	Implement regulations to ensure wells are designed, constructed and operated so as to ensure complete isolation from other strata penetrated by the well, in particular freshwater aquifers.
Treat water responsibly	Reduce freshwater use, store and dispose waste water safely, minimise use of chemical additives.
Minimise emissions	Eliminate venting, minimise flaring and other emissions.
Be ready to think big	Seek opportunities for realising economy of scale and development of local economy infrastructure that can reduce environmental impacts.

Source: Author's elaboration based on IEA 2012.

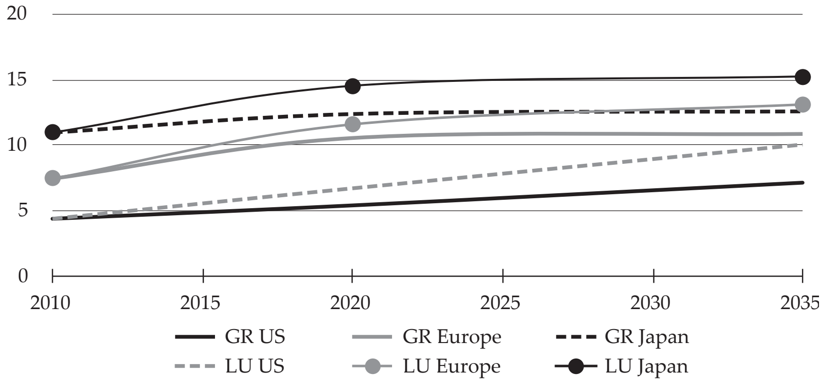
It is expected that compliance with these Golden Rules will increase the cost of unconventional gas production by no more than 7%. This assessment was applied in creation of market forecasts for all regions of the world. Two scenarios of development of world energy sector by 2035 are considered in the report:

- *Golden Rules Scenario* (GR) implies that the conditions necessary to minimize the environmental and social risks will be widely accepted and complied with by all stakeholders.
- *Low Unconventional Scenario* (LU) refers to the absence of social and political agreement on the extensive use of non-conventional resources.

These two scenarios can be considered as of the optimistic and pessimistic a variant of development of shale gas sector in the world. One should assume that the situation in Poland will be largely determined by whether the world situation will be closer to GR scenario or rather to LU scenario. This is why the two scenarios should be taken into account in process of building and simulations on the model for Polish economy.

Prices of natural gas in different markets vary depending on the scenario which is considered. Wide access to unconventional natural gas resources cause a significant increase in supply, which leads to lower prices. The Figure 3 presents price assumptions in scenario GR and LU. The assumption relate to three markets: the U.S., Japan and Europe. In addition, to the figure, the Table 4, shows both price levels adopted in both scenarios and their indexes, as well as the price relationship between scenarios and regions of the world. This facilitate comparison of the scenarios in terms of underlying economic mechanisms.

Figure 3 – Natural gas price assumption (2010 dollars per 1 MBtu)



Source: Author's elaboration based on IEA 2012.

Table 4 – Natural gas price assumptions by case

		2010 US dollars per Mbtu			2010=1	GR=1	US=1	
		2010	2020	2035		2035	2010	2035
Unted States	GR	4,4	5,4	7,1	1,61	1,41	1,00	1,00
	LU	4,4	6,7	10	2,27			1,00
Europe	GR	7,5	10,5	10,8	1,44	1,21	1,70	1,52
	LU	7,5	11,6	13,1	1,75			1,31
Japan	GR	11,0	12,4	12,6	1,15	1,21	2,50	1,77
	LU	11,0	14,5	15,2	1,38			1,52

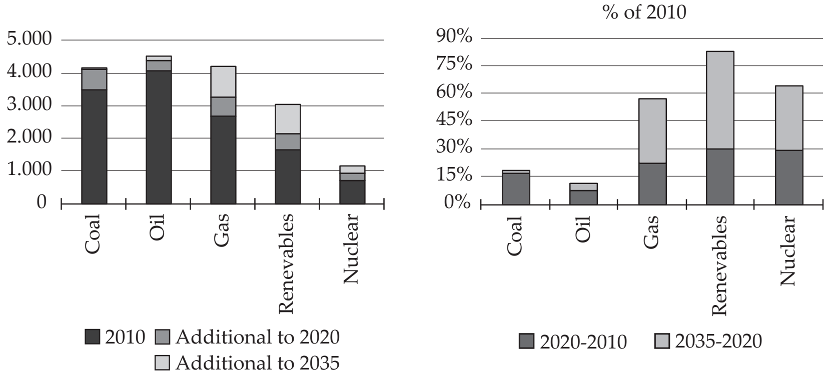
Source: Author's elaboration based on IEA 2012.

Note that in 2035 the GR scenario, prices are higher compared to 2010 by 15% (Japan) to 61% (U.S.). The increase is much higher in the scenario LU compared to the scenario GR, due to the lower gas supply - by 40% in the U.S. and 21% in Europe and Japan. There is a tendency to equalize prices between regions, however, still gas prices outside the U.S. are higher. While in 2010, gas prices in Europe were higher 1.7 times compared to U.S. and in Japan to 2.5 times, then in 2035, in the variant GR corresponding values are significantly lower (1.52 and 1.77, respectively). This effect can be attributed to the increasing globalization of natural gas markets, which is the result of searching for gas customers in more distant parts of the world and spread the transport of gas in liquefied form.

In the LU variant, the tendency to equalize prices between regions of the world is even stronger. After 2020, gas prices in the U.S. chase prices in Europe and Japan, and in the year 2035 are lower than European prices by only 31% and Japanese by 52%. This outcome is the result of having to turn to exploitation of more and more difficult gas resources available in the U.S.

Figure 4 shows the forecast of demand for primary energy by sources in the GR variant. It shows that in the period 2010-2035, the growth in the supply of gas and the reducing of gas price in relation to other primary energy sources, cause that demand for gas grows faster than for coal and oil. At the same time small increase in demand for oil and coal in the period of the greatest expansion of the gas (that is, after 2020), mean that in 2035 gas consumption exceeds the demand for coal and is close to the consumption of crude oil. In a 25-year time horizon prediction of gas consumption increases by almost 60%, while coal and oil only 18% and 11% (respectively). Worthy of note is the significant increase in demand for renewable energy by over 80% and for nuclear by 63%.

Figure 4 – World primary energy demand by fuel in the Golden Rules Case (Mtoe)



Source: IEA 2012.

In the Table 5 the changes in the regional structure of production of natural gas in GR scenario are presented. Poland notes the highest average annual growth rate of production during the period 2010-2035 amounting to 7.1%. In 2035, 90% of gas production in Poland has come up with unconventional gas (practically 100% of shale gas). Slightly lower but high growth rates occur in China (6.6%) and Australia (5.1% – this is mainly due to coalbed methane).

Let us now examine the role of shale gas in various regions of the world through the prism of the share of shale gas in total gas production. The largest part in the year 2035 is expected for North America (68%), thanks to U.S. (71%), Canada (67%) and Mexico (43%). Also countries of Asia-Oceania[5] as well as Asia in the GR scenario produce most of the gas from

[5] Here "Asia-Oceania" means countries of South-Eastern Asia and Oceania. Countries of the rest of Asia (without Russia) are included in the row "Asia".

unconventional resources (64 and 56%). In this scenario, the importance of Russia decrease. The share of Russia in world production of natural gas drops from 19.4% to 15.3%. Position of Middle East countries is maintained and even improved slightly.

Table 5 – Natural gas production by region in GR scenario (bcm)

	2010		2020		2035		2010-2035**
	Total	Share of unconv*	Total	Share of unconv*	Total	Share of unconv*	
OECD	*1.183*	*36%*	*1.347*	*49%*	*1.546*	*60%*	*1,1%*
Americas	*821*	*51%*	*954*	*62%*	*1.089*	*68%*	*1,1%*
Canada	160	39%	174	57%	177	67%	0,4%
Mexico	50	3%	52	12%	87	43%	2,2%
United States	609	59%	726	67%	821	71%	1,2%
Europe	*304*	*0%*	*272*	*4%*	*285*	*27%*	*-0,3%*
Poland	6	11%	9	37%	34	90%	7,1%
Asia Oceania	*58*	*9%*	*121*	*49%*	*172*	*64%*	*4,5%*
Australia	49	11%	115	51%	170	65%	5,1%
Non-OECD	*2.094*	*2%*	*2.635*	*7%*	*3.567*	*20%*	*2,2%*
E.Europe/Eurasia	*826*	*3%*	*922*	*3%*	*1.123*	*6%*	*1,2%*
Russia	637	3%	718	4%	784	6%	0,8%
Asia	*431*	*3%*	*643*	*20%*	*984*	*56%*	*3,4%*
China	97	12%	246	45%	473	83%	6,6%
India	51	2%	75	21%	111	80%	3,2%
Indonesia	88	0%	106	2%	153	37%	2,2%
Middle East	*474*	*0%*	*581*	*1%*	*776*	*2%*	*2,0%*
Africa	*202*	*1%*	*264*	*1%*	*397*	*5%*	*2,7%*
Algeria	79	0%	101	1%	135	8%	2,2%
Latin America	*159*	*2%*	*226*	*4%*	*286*	*22%*	*2,4%*
Argentina	42	9%	53	9%	72	48%	2,1%
World	*3.276*	*14%*	*3.982*	*21%*	*5.112*	*32%*	*1,8%*
EU	*201*	*1%*	*160*	*7%*	*165*	*47%*	*-0,8%*
Poland (share in total of EU)	3,0%		5,6%		20,6%		

* Share of unconventional production in total natural gas production.
** Compound average annual growth rate.
Source: IEA 2012.

Against this background, quite specifically draws the EU position. There are several factors favoring development of unconventional gas production in Europe. First of all, EU is a big market consuming close to 14% of annual yearly gas production (close to 550 bcm in 2010 – see Table 6). Gas infrastructure – pipelines, storages – are well established and prices of natural gas are much higher in comparison with US. The indigenous production has declined by one-third in this century because of the depletion of resources but in the same time consumption has increased slightly. The GR scenario shows that these trends will be continued.

Table 6 – Natural gas indicators in the European Union by case

	Golden Rules			Low conventional		GR-LO*
	2010	2020	2035	2020	2035	
Concumption (bcm)	547	592	645	562	594	51
Production (bcm)	201	160	165	139	84	81
Unconventional	1	11	77	0	0	77
Unconv. share	1%	7%	47%	0%	0%	47%
Cumulative investment in upstream gas (2012-2035)**	434			235		199
Unconventional	181					181
Net imports (bcm)	346	432	480	423	510	-30
Imports as a share of demand	63%	73%	74%	75%	86%	-11%
Share of gas in the energy mix	26%	28%	30%	26%	28%	2%
Total energy related to CO_2 emissions (millions tonnes)	3633	3413	2889	3414	2873	16

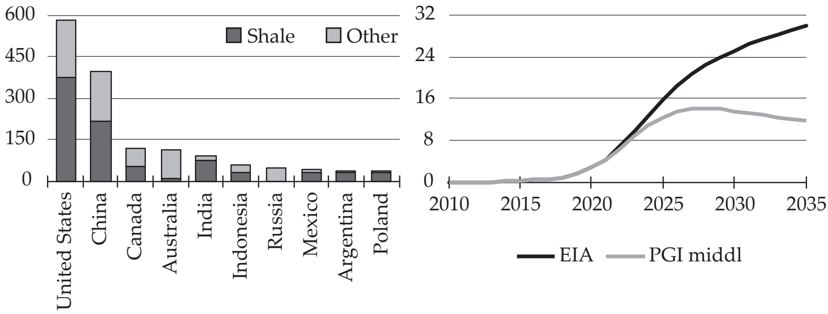
* Difference between the Golden Rules Case and the Low Unconventional Case.
** Investment figures are in billions of year-2010 dollars.
Source: IEA 2012.

Poland stands out in EU in the GR scenario. Production of gas increase by 7.1% on average in the period 2010-2035. This causes that the share of Poland in gas production in the EU is increasing from 3% in 2010 to almost 21% in 2035.

Rising unconventional gas production in Poland and some other EU countries is not able to stop the decline of indigenous production, but the rise in supply (both in Europe and worldwide) helps to restrain the rise in gas prices in Europe. As a result, as well as by measures to promote the use of natural gas, in 2035 the EU consumption can be almost 10% higher compared to 2010 (see table 7) and the share of gas in energy mix rise from 26 to 30%. All of this cause that the increasingly larger part of the demand must be satisfied by imports whose share in meeting the demand for gas in the EU is increasing from 63% to 74% in the period 2010-2035.

The role of the Poland in the IEA projections for unconventional gas is still better visible on the Figure 5. Poland is mentioned here, among the 10 largest shale gas producer in 2035. According to the forecasts, production in Poland in 2035 would reach 30 bcm, which is close to 1.9% of the world unconventional gas production and 2.5% of shale gas extraction.

Figure 5 – Ten largest unconventional gas producer in the GR scenario and impact of different resource assessments on projected shale gas production in Poland (production in bcm)



Source: IEA 2012.

So far, two scenarios were considered: GR and LU. Both of them assume high recoverable resource estimate of 5.3 tcm., but in the LU scenario Poland does not produce shale gas because of social and political obstacles. Studies by the Polish Geological Institute with support from United States Geological Survey (USGS) give a much lower estimate ranging from 346 bcm to 768 bcm (PGI, 2012). The large difference is explained primarily by differences in methodologies between the two studies. More precise estimates will be available in the next few years, as more as more data become available from exploratory drilling. The chart on the right side of figure 10 shows what can happen if actual resources in Poland are significantly lower than assumed in the GR. The GR scenario shows sharp rise of shell gas production after 2020, while the second line represent the production under low resources case using mid-range figure of 0.55 tcm from the Polish Geological Institute estimate. In this case growth of production stops before 2030 at 14.1 bcm. and starts to decline slowly.

It seems that the forecast of the GR scenario should be considered as the most favorable of the possible turn of events for Poland, as it provides that:

1. the forecast uses a very optimistic estimates for shale gas in Poland (5.3 bcm),
2. production does not encounter major difficulties of administrative and social nature and the government is preparing solutions being a viable incentive for potential investors, while maximizing social benefits.

Scenarios for Poland

In the IEA forecast presented above, natural gas production in Poland increase to 34 bcm in 2035 under GR scenario. To assess how important would be this increase for Poland one can refer to the official Polish government document (*Energy Policy ... 2009)*, which provides, among others, the path of growth of primary energy demand. After overcoming some problems related to the comparability of estimates in both documents and making some simple calculations, it can be concluded that in the case of GR scenario:

- Poland until 2020, despite the increase in primary energy demand by about 2% per year, will be able to avoid an increase in imports (import maintain a stable level until 2020) due to an increase its own production of gas,
- in the period 2025-2035 the rate of growth of demand for primary energy decreases to approximately 1.2%. At the same time, faster than in the previous period increase of gas production (at a rate of about 7%) will limit the scale of necessary imports. Thanks this, around 2030 it will be possible to stop the import, and launch export of natural gas surplus.

This is a very rough assessment. It assumes the occurrence of a substitution effect, but does not take into account the possibility of an independent increase in domestic demand for energy, as a result of lowering prices of natural gas. One can raise a number of other concerns, such as the lack comparability of growth rates of GDP as well as energy efficiency in both projections. Their inclusion may change quite significantly the assessment of the Polish self-sufficiency in the supply of natural gas.

It should also be noted that in March 2012 the Polish Geological Institute (PGI) has announced its preliminary report stating that the resources of shale gas in Poland are at least 5 times less. The truth about the resources will be known in several years, when companies with exploration licenses present detailed reports. It seems, that even if the reports confirm the pessimistic estimates, a new subsector of mining industry will appear in Poland in foreseeable future. The realization of this vision would lead not only to significant changes in the structure of energy consumption in Poland and easier achievement of emission targets, but also increase energy security of the country.

In the circumstances outlined above, beginning the exploitation of shale gas in Poland in the next 10 years seems a foregone conclusion. Whether it can affect the European market significantly, depends on the results of geological research as well as political and social situation around the exploitation of shale gas in Poland and in EU. For the simulation purposes at least 3 alternative scenarios for Poland should be considered:

- reference scenario – Poland explores shale gas resources but do not start their exploitation, regardless of the results of exploratory research,
- optimistic scenario – exploration results confirm the existence of shale gas resources at a level similar to the estimates of ARI / EIA and Poland begin their exploitation in accordance with the Golden Rules,

- pessimistic scenario – exploration results confirm the existence of shale gas resources at a level similar to the estimates of PGI and Poland begin their exploitation in accordance with the Golden Rules.

On these variants, alternative assumptions should be imposed concerning developments in the global and European energy market, using scenarios LO and GR from IEA analysis.

Below we discuss in more detail issues which should be taken into account while modeling and preparing scenarios for simulation of shale gas impact for the Polish economy.

After 1990 two opposing processes are observed in Poland. On the one hand, a clear trend to reduce energy intensity measured by GDP per capita can be seen. It is the effect of ever-increasing energy prices, which results in reduction of energy consumption through regular savings and stimulation of technological progress. On the other, the energy consumption is growing due to the process of catching up with developed countries in terms of energy consumption per capita, causing increase of energy intensity of GDP. In the coming decades demand for energy will be still the result of these two processes.

On the supply side, the structure of energy by sources is going to change in Poland. While coal will still continue to form the basis of Polish energy sector, its importance will be steadily decreased due to the policy of the EU, focused on the reduction of greenhouse gas emissions. The rate of reduction of the share of coal in the Polish energy balance will depend on two main factors:

- the rate of implementation of carbon sequestration technologies,
- price competitiveness of renewable energy.

The reference scenario should therefore establish a path for Poland to catch up highly developed countries in terms of energy consumption per capita and / or energy intensity of GDP. The scenario should also include reduction in the intensity of greenhouse gas emissions. This means that prices of energy made from coal increase in relation to those made from other primary sources.

Other important factor influencing the future structure of energy supply in Poland is the situation on the world gas markets and the strength and speed with which they will evolve towards a single market. This will influence the potential of shale gas production in Poland. However, the potential depends also on other exogenous factors of which the most important seem to be the following:

- characteristics of indigenous resources of shale gas (volume, technical opportunities of extraction and its unit costs),
- use the potential of shale gas production on regional markets, like Asia and particularly in China (see CSIS 2012),

- strength of downward pressure of gas prices (including LNG prices) in Europe and in the world.

Taking into account the above determinants and having in mind the general structure of the model IMPEC (see Plich 2009), in Table 7 we indicate the elements of the model which need to be taken into account in construction of scenarios for simulation the impact of shale gas development in Poland.

Table 7 – Elements of IMPEC to change in construction of scenarios

<table>
<tr><th>Supply side</th><th>Demand side</th></tr>
<tr><td>Unit costs of production of shale gas sector (must change according to assumed learning curve - TFP effect).</td><td rowspan="3">Investments:
- modernization of existing power plants and CHP (combined heat and power plants) to replace coal with natural gas,
- construction of new gas power plants,
- exports (pipelines, LNG installations),
- transmission and distribution network depending on location of final customers</td></tr>
<tr><td>Investments in:
- drilling (depending on life cycle of wells),
- gas storage,
- installations for gas liquefaction.</td></tr>
<tr><td rowspan="2">Imports (must take into account long-term contracts for the supply of Russian gas; the contract ends only in 2023 and provides a purchase of at least 8.7 billion m3 per year).</td></tr>
<tr><td>Productivity of new and modernized power plants and CHP</td></tr>
<tr><td colspan="2">Financing of investments (domestic-foreign, public-private).</td></tr>
<tr><td colspan="2">Royalties and taxation.</td></tr>
<tr><td colspan="2">Prices of primary fuels, especially natural gas and LNG in relation to others.</td></tr>
</table>

Conclusions

Over the past decade shale gas has become an increasingly important source of natural gas in the United States, and now is in the center of interest in the world giving hope for stopping ever-rising prices of energy. Currently, there are three main barriers to the development of shale gas in the world: uncertainty as to the actual amounts and their characteristics determining the possibility of extraction, environmental constraints, and political threats.

Estimates of shale gas resources in Poland are promising, which means that the launch of shale gas production over the next few years is very likely. If optimistic assumptions are met, Poland around 2030 can be a net exporter of gas. To assess consequences of shale gas extraction in Poland IMPEC model should be revised by adding new capabilities to reflect possible changes on supply and demand side. A new branch should be explicitly put into the input-output table and various scenarios of investments should be considered. The most significant driver for Polish shale gas industry would be gas prices. If developed successfully, shale gas in Poland will first of all meet domestic demand but in more optimistic scenarios also exports of LNG can be considered.

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