ENERGY POLICY and INTERNATIONAL COMPETITIVENESS

edited by
Maurizio Grassini
Rossella Bardazzi

FIRENZE UNIVERSITY PRESS

ATTI

– 23 –

Energy Policy
and
International Competitiveness

edited by
Maurizio Grassini
Rossella Bardazzi

firenze university press
2009

Energy Policy and International Competitiveness /
edited by Maurizio Grassini and Rossella Bardazzi.
– Firenze : Firenze University Press, 2009.
(Atti ; 23)

http://digital.casalini.it/9788864530437

ISBN 978-88-6453-040-6 (print)
ISBN 978-88-6453-043-7 (online)

Università degli Studi di Firenze
Dipartimento di Studi sullo Stato

This work has been financed by the PRIN 2005 grants on the project "Deepening and Enlarging the European economy: an integrated modelling approach" (#2005139514) coordinated by the University of Florence.

Immagine di copertina:
© Rolffimages | Dreamstime.com

Progetto grafico di Alberto Pizarro Fernández

Università degli Studi di Firenze
Firenze University Press
Borgo Albizi, 28, 50122 Firenze, Italy
http://www.fupress.com/

Printed in Italy

CONTENTS

Maurizio Grassini and Rossella Bardazzi (edited by), *Energy Policy and International Competitiveness*,
ISBN 978-88-6453-040-6 (print) ISBN 978-88-6453-043-7 (online)

INTRODUCTION

Rossella Bardazzi, Maurizio Grassini

Inforum (Interindustry Forecasting Project at the University of Maryland) was set up in 1967 by Clopper Almon, now Professor Emeritus of the University of Maryland. Inforum pioneered the construction of dynamic, interindustry, macroeconomic models which portray the economy in a unique "bottom-up" fashion. This modelling approach, once called the 'modern input-output' model and now known by the more descriptive 'Macroeconomic Multisectoral Model', is described in a number of papers available on the web site www.inforum.umd.edu.

Over the last 30 years, Inforum has directed much of its efforts to developing a linked system of international macro/interindustry models, all constructed with a consistent methodology. A world-wide network of research associates has been established, each of which uses Inforum modelling methods and software. The Inforum partners have held annual conferences since 1993 to further the work of empirical input-output modelling and analysis and data development techniques, through the presentation and publication of papers representing the work of Inforum activities worldwide.

A selection of contributions presented at the XVI Inforum World Conference held in North Cyprus in September 2008 has been made in this publication. Most papers are devoted to the same two topics: energy and competitiveness. Although the studies were conducted in different countries and with different perspectives, these issues are very high in policymakers' agendas worldwide. Another set of papers refers mainly to methods and data issues, as these are both of paramount importance in economic modelling: proposing new solutions to complex problems and keeping up to date with the content of official statistics has always been crucial for the Inforum approach.

Energy policies in the US, China and Russia are analyzed in the contributions of the first section. These countries present very different situations as regards energy resources and policies but they all share the common concern of our times about energy saving and sustainable development, albeit with distinct awareness and policy strategies.

Maurizio Grassini and Rossella Bardazzi (edited by), *Energy Policy and International Competitiveness*,
ISBN 978-88-6453-040-6 (print) ISBN 978-88-6453-043-7 (online)

The economic impact of the Energy Independence and Security Act (EISA) passed by the U.S. Congress in 2007 has been analyzed by **D.Meade** with the LIFT model of the U.S. economy. This work highlights the abilities of Inforum models to study structural changes brought about by either a shock or an economic policy, and the flexibility of this tool which in this specific analysis has been extended by the addition of modules for ethanol production and for increased fuel efficiency in vehicles, induced by a number of legal provisions. The main goals of this legislation are to reduce the dependence on imported oil through an increase in production and consumption of renewable fuels and an increase in fuel efficiency. Results of this study show that by 2030, aggregate GDP and real income will fall slightly in the EISA scenario due to a reduction of personal consumption expenditure and exports which can be explained by a higher price level. However, at the industry level, there are winners and losers: for instance, Agriculture, Other Chemicals and several other industries related to vehicle production are positively affected while conversely, other industries, mainly connected with oil production and refining, will reduce their output.

The energy sector is of central importance to the Russian economy, so in 2007 the government developed a long-term strategy – up to 2030 – to switch the generation of electric power from natural gas to coal so that gas resources could be exported and, at the same time, the huge existing stock of coal be consumed. In their contribution **A. Shirov** and **A.Yantovskiy** use a set of economic models to simulate the impact of this policy on the Russian economy. They also forecast the future development of the Russian oil industry carefully taking into account the size of oil reserves, extraction costs and the transition from old to new cheaper deposits. This policy, associated with a labour wage reform to increase household income and reduce the tax burden on business, will increase GDP growth in the long term and develop the energy sector further . The negative impact on the environment generated by the increased use of coal for electricity production could be overcome by investments in green technology to improve the energy efficiency of the economy.

The Chinese energy sector is analysed, albeit from different perspectives, by the contributions of **L.Shantong -H.Jianwu** and **P.Shengchu -F.Mingshuo**. Over the last decade China has enjoyed very high economic growth driven mainly by investment and foreign trade. During this period the rate of growth of energy consumption (for example 16 per cent in 2003) exceeded that of the economy (around 10 per cent). Moreover, China has a large surplus in the commodity trade with a high share of energy intensive products. Shantong and Jianwu use IO methods to analyse the *embodied energy* consumed in the entire production process of a specific commodity, concluding that China is a net exporter of embodied energy – mainly to the U.S. and Japan – and a net importer of greenhouse gas emissions due to rapid growth in sectors such as ferrous and non-ferrous metallurgy, transportation equipment manufacturing and chemicals, required by the high investment in infrastructures and urbanization. The authors suggest a need for public intervention for better city planning and a choice in favour of railroad transportation instead of motorways to address the rising concern about energy saving and environmental protection without jeopardising economic growth. An energy saving plan has already been approved by the Chinese government to reduce energy consumption by 20 per cent by 2010. The economic effects of this policy have been analyzed using the Mudan model, a multisectoral Inforum model of the Chinese economy, by Shengchu and Mingshuo. In their study two simulations are performed: a) a reduction of energy consumption (coal, crude oil and natural gas) by 4 per cent every year from 2006 to 2010; b) the improvement of efficiency of transport fuel. Mudan shows that these policies may have a positive effect on the Chinese economy both in terms of economic growth and of the energy trade balance.

In 2004 the European Union expanded to include ten new member States among which some fast-growing small economies such as the Baltic countries. Economic growth in these countries is explained mainly by the development of the service sector while manufacturing lags behind. **R.Počs, A.Auziņa, V.Ozoliņa**, and **G.Piņķe** analyse the characteristics of Latvian manufacturing industries to estimate productivity changes and their impact on the economy up to 2020. An Inforum model for Latvia developed by the research team was used for this study: sectoral results show that further convergence towards EU levels of productivity is expected while the population and labour force will decrease, though no additional immigration is required to maintain economic development.

Another Baltic economy, Estonia, was analyzed by **T.Paas** and **J.Sepp** in a comparative study of the sectoral economic structure of EU-27 member states using Eurostat disaggregated data. By using factor analysis, aggregate indicators are computed to explore the relationship between economic structure and productivity: one factor F1 describes the development level of a post-industrial service economy and a second factor F2 can be interpreted as the indicator describing the environment of technological innovation. Both indicators are normally low in the new member countries. In particular Estonia is characterized by a low level of manufacturing-based, technological innovation suggesting that its future development will be similar to that of Southern European countries, fitting the of catching-up terziarization model .

L.Ghezzi and **R.Paniccià's study** presents a multisectoral, multiregional model of Italy built at IRPET, the Regional Institute for Economic Planning of Tuscany. This work focuses on interregional trade: the model is indeed used to evaluate the impact of foreign exports on Italian regional growth. Since the 1990s, Italy has experienced a decreasing elasticity of GDP on exogenous final demand while foreign exports represent the most important driving force in the growth process. The reduction of the export-GDP multiplier can be explained partly by the outsourcing process but also by changes in the sectoral mix of Italian exports. Moreover, regional spillover effects of foreign exports among regions can be computed: international trade triggers impulses which can be transmitted through interregional trade. Simulation results show that spillovers differ from one region to another depending on economic structure but also that some low export –oriented regions can benefit from these effects, taking advantage of the impulse from the higher exporting regions.

The contribution by **P.Salmon** and **G. Özhan** presents a step-by-step description of the building process of an Inforum-type model for Turkey. From the acquisition of sectoral data and national accounts, the assumptions needed to build a first draft of an identity-centered economic model to the basic commands for running a simulation and producing an illustrative forecast: this work is an example of how to start a project and build a *tiny* multisectoral model for an economy where data availability is not fully guaranteed.

Finally, the second section ends with a paper by **Ł. Tomaszewicz** and **I. Świeczewska** which measures the extent to which the efficiency of Polish industries is driven by their potential to innovate and to what extent it is a result of the diffusion of other industries' and foreign partners' innovation. An input-output approach is used to estimate the benefits of the inter-industry diffusion of innovation via intermediate inputs. The main conclusion of this analysis is that imports play a special role as a source of innovation in Poland: R&D expenditures by trade partners increase efficiency in Polish economy more than the same amount at the domestic level.

The final section of the book gathers together s several contributions which share a common interest in the statistical environment and in the methods implemented within the framework of multisectoral econometric models such as Inforum. **J.Richter** illustrates in great detail the future developments of official statistics and their implications for economic modelling, particularly at the European level. Changes in classification systems are always a challenge for long-term model builders as they imply a disruption of all time-series especially if no backward data is requested from the national statistical institutes. The author stresses that the planned revisions do not take the needs of model builders into account: industries are still very heterogeneous and vertical integration characterizes some important sectors such as Manufacturing of paper and paper products. Some industry divisions will be aggregated with serious repercussions on sectoral analysis. Therefore, additional efforts to transfer the existing economic models from the old classification system to the new one will be needed.

In his contribution **M.Uzyakov** illustrates a remarkable work of producing a set of I-O tables for Russia in the period 1980-2006 to perform sound economic analysis for this country undergoing major structural changes. In the last decade, the Russian economy has been characterized by positive strong dynamics of exports, imports and personal consumption while investments and government expenditures grew more slowly. This result can be explained by the adaptation of the investment process to the crisis, decline and subsequent recovery of production after the collapse of Soviet Union, while for public expenditure it reflects the decreasing role of the state in the transformation towards a market economy and the reduction of military expenditure. A detailed picture of structural changes in the Russian economy can be observed through the set of I-O tables produced by the author.

This data set was indeed used by **C.Almon** to apply an input-output based method to measure changes in the efficiency of the whole economy in producing various products for final demand. In his contribution, the author first demonstrates the fallacy of double deflation to take into account the use of intermediate inputs in measuring productivity. Double deflated value-added consists of deflating the output of a sector and then subtracting the deflated value of intermediate inputs from it. Although this is standard procedure suggested by many international organizations (such as OECD) and applied by statistical institutes, Almon demonstrates that if sectoral price changes are significant, the results of this method are nonsense or, in the author's words, *statistical muck*. Almon presents an alternative input-output method based on the calculation of how many resources go into delivering one unit of each product to final demand. This method is then applied to the Russian 44-sector I-O tables and results for the period 1995-2006 show a general negative change in productivity for several years after the demise of the Soviet Union while in the 2000-2006 period most products show a reduction of input requirements, with the fastest growth in productivity for some service sectors, construction and agriculture.

The last contribution of the book by **M.Grassini** is an example of how important bilateral trade flow datasets may be for economic analyses. The author considers the import and export flows and their forecasts, required from each member state every year according to the Stability and Growth Programmes (Convergence Programmes for member states outside the Euro area). A Bilateral Trade Tool based upon Comext data is then used to simulate several scenarios: a baseline scenario built on Inforum forecasts is compared with a second scenario including the forecasts produced by each EU country in the annual Programme. From the simulation results a systematic bias appears between the EU15 and the EU12 group of countries (the member states which joined after 2004): while the old member states underestimate the export growth rate, the new ones forecast an export performance which is too optimistic if compared to the bilateral trade flows registered by Eurostat. Although these Programmes are thoroughly revised by the European Commission' services, this study highlights that each Member State is considered separately from the rest of the European Union even in a matter such as international trade where bilateral relations are of the utmost importance.

ENERGY ISSUES

AN ANALYSIS OF THE ECONOMIC IMPACTS OF THE 2007 ENERGY INDEPENDENCE AND SECURITY ACT*

Douglas S. Meade
Inforum, University of Maryland, College Park, MD

In December 2007, the Energy Independence and Security Act (EISA) was passed by Congress. The main goal of the EISA is to reduce U.S. dependence on imported oil. Our study assesses two major provisions of the Act, which have the most impact on oil imports: (1) an upward revision to the Corporate Average Fuel Economy (CAFE) standards and (2) a mandate for a significant increase in production and consumption of renewable fuels – the Renewable Fuels Standard (RFS)[1].

The EISA raises the CAFE standards for cars and light trucks by 40% between now and 2020, from 25 miles per gallon (mpg) to 35 mpg, a 2.9% average annual increase in fuel efficiency. It also sets a target of 36 billion gallons of ethanol by 2022, up from about 6 billion gallons in 2006, an annual average increase of 11.9%.

This study analyzes the structural and economic changes brought about by the implementation of the EISA. The INFORUM LIFT model of the U.S. economy is extended with additional modules enabling it to analyze ethanol production, as well as to project consumption of motor fuels based on number of vehicles, average mpg, and miles driven. We compare two scenarios: (1) a «business as usual» scenario, that projects the ethanol production and vehicle mileage without the EISA, and (2) an «EISA» case, that incorporates the CAFE standards stipulated in EISA, along with an increase in ethanol production, though not nearly as high as that stipulated by EISA.

This paper reviews how the LIFT model was extended to study ethanol production and CAFE standards, how the model was used to implement these scenarios, and summarizes the results of the simulations. We

* This study was initiated, supported by, and substantially designed by the U.S. Department of Commerce. David Henry of the Economics and Statistics Administration and Kemble Stokes of the International Trade Association were the primary contributors. However, any statements and results presented in this report are solely the responsibility of the author, and do not reflect views held by the Department of Commerce.

[1] The various provisions of the EISA 2007 are summarized in Sissine (2007).

Maurizio Grassini and Rossella Bardazzi (edited by), *Energy Policy and International Competitiveness*,
ISBN 978-88-6453-040-6 (print) ISBN 978-88-6453-043-7 (online)

find small negative macroeconomic impacts of EISA by 2020 and 2030, on the order of 0.6% and 0.9% of real GDP, respectively. Although the EISA is successful at reducing crude oil imports by nearly 14% by 2030, this is not enough to offset the negative effects on output, jobs and real disposable income.

1. *Introduction*

Background

In comparison with the EU, Japan and other OECD countries, the U.S. has been a laggard in saving energy and reducing greenhouse gas emissions. Energy taxes are relatively low in the U.S. and the U.S. failed to ratify the Kyoto protocol for the reduction of greenhouse gases (GHGs). Nevertheless, concerns about global warming have been growing, and the recent runup in the price of oil has brought questions of energy efficiency and conservation back into the public arena. After the 2006 elections, there was a change in leadership in the House and Senate. In 2007, the new Congress put energy legislation high on its agenda. In addition, President Bush proposed his «twenty in ten» initiative in the 2007 State of the Union Address. His stated goal is to reduce gasoline usage by 20 percent in ten years, through increasing the supply of alternative and renewable fuels, and by reforming and modernizing the CAFE standards.

Table 1 reviews some of the more important energy and environmental legislation that has been recently introduced in Congress. With the exception of EISA and the Energy Policy Act of 2005, none of these bills have yet passed, but they have stimulated a lot of controversy and economic analysis. Common wisdom is that some form of greenhouse gas legislation could pass in the next Congress. However, in the current legislative environment, it is difficult even to get these bills out to the floor for debate. It is significant that the bills that have passed don't promise higher energy taxes or energy prices. When Americans are feeling the pain of higher energy prices, it is difficult to get consensus on greenhouse gas legislation that will probably raise energy prices even further.

Major Provisions of EISA 2007

The Energy Independence and Security Act of 2007 (P.L. 110-140, H.R. 6) is an omnibus energy policy law, consisting mainly of provisions to increase energy efficiency and the availability of renewable energy. The major provisions are as follows:

1. Corporate Average Fuel Economy (CAFE). The law sets a target of 35 mpg for the combined fleet of cars and light trucks by model year 2020. The new standards are based on a mathematical function of vehicle attributes, so that the standards cannot be satisfied simply by adjusting the mix of cars and trucks produced. Interim standards will be set, beginning with model year 2011. Manufacturers will be required to come within 92% of the standard for a given model year, and civil penalties will be assessed for non-compliance.
2. Renewable Fuels Standard (RFS). The law sets a modified standard that starts at 9 billion gallons in 2008 and rises to 36 billion gallons by 2022. Of the latter total, 21 billion gallons is required to be obtained from cellulosic ethanol (16 billion gallons) and other advanced biofuels (5 billion gallons), including biodiesel.
3. Energy Efficiency Equipment Standards. This part of the law includes a variety of new standards for lighting and for residential and commercial appliances.
4. Repeal of Oil and Gas Tax Incentives. Two tax subsidies to the oil and gas industries are repealed to offset the estimated costs to implement the CAFE provision.

The main goals of the legislation are to reduce gasoline usage, and therefore reduce dependence on imported oil.

Summary of the Modeling Strategy

The INFORUM *LIFT* model was used to analyze the most important impacts of EISA. In particular, the main assumptions incorporated into the model relate to the Corporate Average Fuel Economy (CAFE) standards and the Renewable Fuel Standard (RFS)[2] provisions of the Act. The simulations did not incorporate assumptions as to the energy efficient equipment standards, nor of the repeal of the oil and gas tax incentives.

The modeling strategy consisted of developing two scenarios, a «business as usual» (BAU) case, and an EISA case. To develop the EISA case, we started with the published Department of Energy (DOE) Annual Energy Outlook (AEO) baseline from March 2008 (which already includes estimated impacts of EISA 2007) and calibrated *LIFT* to the AEO macroeconomic and energy consumption projections. In other words, the

[2] We chose to follow the AEO in assuming that the RFS would not be met by 2022, but that only 22 billion gallons of ethanol would be produced, 20 billion from corn, and 2 billion from cellulosic and other. The motivation for this assumption is discussed in more detail below.

EISA case is consistent with the published AEO. The (BAU) case was developed by removing the EISA provisions from the assumptions, to model the projected path of the U.S. economy in the absence of EISA.

In order to accurately capture the impact of increased production of corn and cellulosic ethanol, as well as the impact of the CAFE standards, several submodules or model extensions were developed for *LIFT.* These submodules include calculations of variables that are used to make assumptions about flows or input-output (IO) coefficients in *LIFT.* For example, the increased use of corn and cellulosic biomass in ethanol production results in a change in the IO coefficient from the *LIFT* Agriculture, forestry and fisheries industry (1) into the Other chemicals (23) industry, which includes ethanol production. Increased fuel efficiency in autos and light trucks was modeled partly by changes in the personal consumption of gasoline, but also in the IO coefficients of fuel used by the business sector.

2. Modeling the EISA

Advantages of LIFT for this Study

The INFORUM *LIFT*[3] model embodies a quantity and price IO model within a full macro model. The forecasts of the model are based on empirically estimated econometric equations for final demand components, employment and value added by industry, and for many of the macro variables. *LIFT* has commodity detail for 97 sectors[4], and value added for 51 industries comprising the U.S. economy. Many of the macro-variables in the model are determined as aggregates of the corresponding sectoral variables. Nominal GDP components such as labor compensation, corporate profits, proprietors' income and capital consumption allowances are formed as the sum of the values by industry. Real GDP is formed as the sum of detailed final demand variables. The aggregate GDP deflator is simply the ratio of aggregate nominal GDP divided by real GDP. Total employment is the sum of employment by industry plus government employment.

The IO coefficients play a pivotal role in the model, in the determination of both output and prices. They are not constant, but are projected to change over time, based on logistic equations that indicate that all coefficients in a row of the IO table should rise or fall at the same rate. They can be modified by special assumptions, called «fixes», in a given scenario. For example, calibration of LIFT industrial electricity use to the

[3] See Meade (2001) for a summary of the *LIFT* model.

[4] See Appendix B for a full list of the 97 commodity sectors in *LIFT.*

Department of Energy AEO projection is achieved by modifying coefficients of Electric utilities (66) in the industrial sectors (1-58).

The *LIFT* model is particularly suited for studies examining the interplay of industry behavior and the macroeconomy. For example, in studying the effects of energy price changes, *LIFT* can address the effects of relative price changes on consumption, as well as the impact of energy prices on the aggregate GDP or PCE deflator. Higher oil prices lead to reduced consumption of petroleum products, and thus reduce real oil imports. However, nominal imports are likely to be higher, as oil is relatively price inelastic.

LIFT is not an energy model, and doesn't include the great degree of detail by energy product and end use that is found in a modeling system such as the DOE National Energy Modeling System (NEMS)[5]. However, *LIFT* includes many IO flows, sectoral variables and macro variables that relate to variables in NEMS. The knowledge base from NEMS can be incorporated into *LIFT* through fixes that calibrate *LIFT* variables to those in NEMS. Furthermore, the *LIFT* model incorporates energy flows, interindustry transactions and macro variables into one internally consistent forecast. For this study, several submodules were developed to relate specific details of ethanol production and consumption and of vehicle miles traveled and fuel efficiency to variables already in LIFT.

Calibration of LIFT to the Annual Energy Outlook

The *Annual Energy Outlook* (AEO) is normally published by DOE once a year, in February. The AEO currently has projections out to 2030, and includes tables on the macroeconomic outlook, energy prices, energy consumption, energy production and imports, and energy-related carbon dioxide emissions. Tables are available in Excel format, with values of many NEMS variables from the 2005 to 2030[6].

This year, due to the passage of EISA in December 2007, a revised version of the AEO was released in March 2008, incorporating estimates of the effect of EISA, as well as revised macroeconomic growth assumptions. The *LIFT* model was calibrated to this revised AEO for the EISA case. The strategy followed was to get exogenous variables calibrated first, and then to work forward into variables with greater and greater degrees of endogeneity. The details of this calibration are described in Appendix A.

[5] NEMS is the modeling system used by DOE in the *Annual Energy Outlook*, and for numerous analyses of energy and environmental legislation. Documentation on NEMS can be found on the DOE web site at <http://tonto.eia.doe.gov/reports/reports_kindD.asp?type=model%20documentation>.

[6] These tables are available at <http://www.eia.doe.gov/oiaf/aeo/>.

The Ethanol Submodule and Ethanol Assumptions

The ethanol submodule in *LIFT* was developed to explicitly show the accounting for ethanol feedstock (corn or cellulose) use, other input requirements, plant and equipment investment requirements, capacity, production, number of plants, average plant size, and capacity utilization. Some variables calculated in the ethanol model are converted back to constant dollars to guide IO coefficient change in the main *LIFT* model.

Table 2 shows assumptions used in the BAU and EISA cases for corn and cellulosic ethanol production. Annual production of corn ethanol is assumed to reach 15 billion gallons by 2030 in the base, and 20 billion gallons in the EISA case. Cellulosic ethanol production is assumed to reach only 2.1 billion gallons in the base and 12 billion gallons in the EISA case. Capacity for both types of plant is assumed to grow slightly ahead of production, so that capacity utilization ratios are generally between 80 and 95 percent.

The RFS mandates that by 2022 the use of corn ethanol should rise to 15 billion gallons, and that of cellulosic ethanol should rise to 21 billion gallons, for a total of 36 billion gallons of ethanol. Following the AEO, we decided to only assume 22 billion gallons by 2022, of which 2.1 billion gallons is cellulosic ethanol. By 2030 we assume that total production rises to 32 billion gallons, of which 12 is cellulosic ethanol, and 20 is corn ethanol. Although news reports often refer to imminent «breakthroughs» in the production of cellulosic ethanol, the fact is that there are no commercial-scale cellulosic biofuel plants in the United States, and there are only a few demonstration-scale plants in the U.S. and Canada. Many scientists suggest that commercial realization of cellulosic ethanol is still 5 to 15 years away[7].

Investment requirements for ethanol are calculated by assuming a certain incremental capacity cost, measured in 2008 dollars of investment per gallon of production capacity. For corn ethanol plants, this cost is fairly well understood, and is currently about $1.50 capital cost for gallon of capacity. In other words, a 50 million gallon plant will have an initial plant cost of $75 million, in today's prices. For this study, we assumed that the incremental capital cost falls further to $1.30 by 2015, and remains flat thereafter. Much less is known about cellulosic ethanol plants. We assume a current incremental capital cost of $7.20 per gallon of capacity. Assuming that economies of scale and learning by doing will bring this cost down, we specify that it falls to $5.60 by 2015, and to $3.00 by 2030[8]. The pro-

[7] See Yacobucci and Capehart (2008) for discussion of constraints to the realization of the goals of the RFS.

[8] The incremental investment costs for corn and cellulosic ethanol plants were taken from the AEO 2007, p.58. Efficiency improvements for the investment costs for cel-

jected investment expenditure is simply the change in capacity multiplied by the incremental capacity cost. These costs are shown for both corn ethanol and cellulosic ethanol in the line labeled 'Investment'.

Feedstock requirements for ethanol production are calculated in quantities, then converted to constant dollars for the purpose of calculating changes in IO coefficients. For corn ethanol, corn inputs are measured in physical units in billions of bushels (bil. bu.).

In order to relate corn ethanol production to the context of overall corn production and use, a module for corn supply and disposition was developed that presents results similar to those in the corn table of the USDA Baseline Projections (currently available to 2017)[9]. The USDA baseline was used as our starting point. However, since the ethanol projection in that baseline is slower than either the base or the EISA case, we made some downward adjustments to exports and feed use to keep the non-ethanol Food, seed and industrial (FSI) at about 2.5 bil. bu.

The impact of corn ethanol production on the corn market is very sensitive to assumptions about the productivity growth of corn production, and the number of acres planted and harvested. For this analysis, we assumed productivity growth in both the production of corn, and in the conversion of corn to ethanol. In both simulations, we assume that acreage planted in corn is the same, starting at 88 million acres in 2008, and staying at 92 million acres from 2020 to 2030. This acreage constitutes about 21% of total US cropland, with total cropland holding steady at 434 million acres. Acres harvested is related to acres planted by regression, using historical USDA data, and reaches 84.6 million acres by 2030. The productivity measure, bushels per acre, starts at 148.4 in 2008, and climbs to 190 by 2030[10]. With these assumptions, corn production reaches 14.2 billion bushels by 2015, and 16.1 billion bushels by 2030. The corn to ethanol conversion rate is assumed to start at 2.91 (gallons per bushel) in 2008, reach 3.0 by 2022, and reach 3.1 by 2030. Combining these assumptions, we find that the ethanol per acre harvested of corn starts at 432.2 gallons in 2008, reaches 500.6 gallons in 2015, and 589 gallons in 2030.

Table 3 shows some of the results of the ethanol submodule calculations for both cases. For each variable displayed in that table, there are two lines. The first line shows the value in the BAU case, and the second line shows the value in the EISA case. Total corn devoted to ethanol production in the base case reaches 4.8 billion bushels by 2030 in the base

lulosic ethanol plants were determined in consultation with industry experts from the MITRE Corporation.

[9] The USDA Agricultural Baseline can be found at <http://www.ers.usda.gov/publications/oce081/>.

[10] We used the USDA Baseline yield per acre harvested figures through 2017, and extended these to 2030 linearly.

case, and 6.5 billion bushels in the EISA case. In percentage terms, this implies that ethanol production constitutes 30.1 percent of total corn production in the base case by 2030, and 40.1 percent in the EISA case. In both the base and the EISA case, corn available for feed and for exports is reduced from the initial USDA-based projection, to make room for ethanol demand. In the EISA case, corn exports fall to 1.1 billion bushels in 2015, but rise eventually to 1.9 billion bushels by 2030.

In this study, we also assume a significant growth of ethanol imports. However, we assume the same import trajectory in both the BAU and the EISA case. Imports reach 2.4 billion gallons by 2014, and 7 billion gallons by 2030, in both cases. Total ethanol supply consists of corn ethanol, cellulosic ethanol and imports. In the base case, supply reaches 17.1 billion gallons by 2015, and 24.1 billion gallons by 2030. In the EISA case, the figures are 20.6 and 39.0, respectively.

Corn requirements for ethanol are converted to constant dollars, using the USDA historical price ($/bu). Cellulosic biomass requirements for ethanol are taken from a National Renewable Energy Laboratory (NREL) paper[11], which provides a figure for corn stover of $0.49 per gallon in 1999 dollars. Although not all cellulosic ethanol may be produced from corn stover, we assume that other biomass costs are comparable. The IO coefficient of Agriculture, forestry and fisheries (1) to Other chemicals (23) (A(1,23)) is modified in both the base and the EISA case to account for these increased purchases of feedstock from the agricultural sector.

The blending of ethanol into gasoline is modeled by assuming an increased flow from Other chemicals (23) into Petroleum refining (24). The IO coefficient A(23,24) is modified by first converting the ethanol supply to constant dollars, then adding it to the existing IO flow, and creating a new coefficient projection.

For a given quantity of gasoline demand, the increased ethanol composition translates into a reduction in crude petroleum requirements. This is calculated by assuming that one gallon of ethanol substitutes for 2/3 gallon of petroleum-derived gasoline, and that one barrel of oil produces 19.5 gallons of gasoline. We then calculate the reduction in barrels of oil required for petroleum refining, convert this quantity to constant dollars, and modify the IO coefficient of Crude petroleum (5) into Petroleum refining (24).

Corn and Agriculture Price Assumptions

Farm prices have increased sharply over the past two years in the U.S. The index of prices received by farmers for all farm products has increased

[11] McAloon *et al.* (2000).

34 percent from January 2006 to May 2008. The index of prices received for seed grains and hay has increased by 144 percent over that period. High farm prices have contributed to significant retail food price increases, which rose 4.9 percent in 2007, the largest increase in 17 years[12]. Since these price increases have accompanied a surge in ethanol production, many observers have blamed the increase in farm prices on the pressure on the corn market due to ethanol. Others point out that there are several factors behind the high prices, including strong global economic growth, the declining value of the dollar, reduced global supplies due to bad weather conditions, high energy prices that raise production costs, and changes in foreign agricultural policies. Not surprisingly, trade associations representing the ethanol producers and the corn growers have argued that the effects of ethanol production on corn and other farm prices are not that significant, and that the other factors listed above are more important.

The debate over the issue is contentious, and rising sentiment against the ethanol mandates may lead to pressure in Congress for a relaxation of the RFS. However, the issue requires careful analysis, and quantifying the effects of ethanol on food prices is difficult. One approach is to view the increase in corn ethanol production as a demand shift for corn, and then estimate the supply elasticity and the resulting price multiplier. Recent testimony by the USDA chief economist suggests that this multiplier is in the range of 2.6 to 3.0[13]. Several studies have analyzed the increase in corn prices from 2006 to 2008, and suggest that the increase in corn ethanol may account from between 28 to 55 percent of the recent corn price increases. Of course, recently the increase in corn used for ethanol has been relatively large as a share of total corn production (an increase of 4.2% in 2007).

Using a similar technique, we can estimate the effect on the corn price of increased ethanol production in the EISA case versus the BAU case. Table 4 shows corn production for ethanol in the BAU and EISA cases in the first two rows. The next line shows the difference, which is the additional corn needed for ethanol production in the EISA case. Dividing this difference by total corn production we obtain the demand shift due to ethanol production, calculated as a percentage of total production. This is roughly 10 percent in 2020. If we take for a value of the price multiplier the middle of the range of estimates mentioned above

[12] Collins (2008).

[13] The multiplier is defined as the percentage by which the corn price is expected to increase in response to a one percent increase in demand (in this case, in ethanol production). Joseph Glauber's testimony includes a table on p. 11 that purports to show what the corn price would have been in the absence of increased ethanol production. The implied multipliers were calculated from this table. See the References for the title and URL of this testimony.

(2.8), this implies that the difference in the corn price between the two cases will be about 28 percent in 2020.

The increase in corn prices may have more impact than is indicated by the production of corn alone. For example, soybeans competes for acreage devoted to corn, and also competes as an ingredient for animal feed. Collins (2008) argues that the price effect of ethanol on corn can be expected to cause soybean prices to rise in proportion. Wheat prices are also affected by corn prices to a certain extent, though not as directly. Furthermore, higher corn prices raise the price of growing livestock and poultry.

For the last year for which we have complete data (2006), the share of value of corn and soybeans in the total Agriculture, forestry and fisheries sector was 11.6 percent. We assume that only these two product prices are affected by the increase in ethanol production. The final change in the price change assumed for the full Agriculture, forestry and fisheries sector in *LIFT* is then the product of this share (0.116) and the corn price increase (28% in 2020). The result is a 3.2 percent change in price in EISA with respect to the BAU case in 2020.

The Vehicle Fuel Consumption Submodule and Assumptions

LIFT normally calculates personal consumption of gasoline in constant dollars, using a consumer demand system. In this system, gasoline is one of 92 categories of consumption goods. Business use of gasoline is calculated (also in constant dollars) in the IO model, using coefficients for the petroleum refining row into other industries. For this study, we developed an alternative approach to forecasting gasoline consumption, based on explicit accounting for fleet miles per gallon (mpg) of autos and light trucks.

The data used to develop this module were taken from the Department of Transportation *Transportation Statistics*[14]. Data were used for the following categories of vehicles:

1. Passenger cars
2. Motorcycles
3. Other 2-Axle 4-Tire Vehicles (light trucks)

For each vehicle type, the following characteristics or variables are available:

1. Number registered
2. Vehicle-miles traveled (total)
3. Fuel consumed (total)

[14] Table 4-11 *Passenger Car and Motorcycle Fuel Consumption and Travel*, and Table 4-12 *Other 2-Axle 4-Tire Vehicle Fuel Consumption and Travel.*

4. Average miles traveled per vehicle
5. Average miles traveled per gallon
6. Average fuel consumed per vehicle

The model first calculates projections for the number of vehicles, average miles traveled per vehicle, and average mpg. It then calculates total vehicle miles traveled (VMT), fuel consumed, and fuel consumed per vehicle by identity.

To forecast the number of vehicles, we first construct an estimate of the capital stock of vehicles, by cumulating annual domestic purchases of motor vehicles, and using a stock depreciation rate of 7.5%[15]. We then relate the growth rate of autos and light truck stocks to this stock measure, but modify the growth of each category so that the composition changes from the 52% autos / 48% light trucks mix in 2008 to a 65/35 mix in 2030. This reduction in the share of light trucks over time was assumed to be driven by higher energy prices.

The changing of the capital stock is also essential to understanding the average fleet mpg. For both passenger cars and light trucks, we assumed that new vehicles satisfied the CAFE standards, and implicitly tracked the effect of the different mpg of successive vintages by cumulating them into the capital stock, and then taking the average mpg of the existing capital. The mpg calculated in this way lags the actual CAFE standards, but if the CAFE standards stop increasing, the mpg average will catch up to CAFE level[16].

Finally, the average miles traveled per vehicle was first calculated by using a time trend projection. However, this equation gave vehicle-miles traveled projections that grew too fast[17]. The VMT per vehicle projections were modified to grow more slowly, and the projections for number of vehicles were adjusted down to keep the total VMT growing at a rate closer to the AEO.

The assumptions and results of the model calculations are shown in Tables 5 and 6. The number of passenger cars grows from 140.7 million in 2008 to 217.6 million in 2030 in the base, and to 219.0 million in the EISA. The number of light trucks grows more slowly, from 100.3 million in 2008 to 116.6 (116.8 in EISA) million in 2030. In the base case, the average passenger car mpg grows from 22.5 in 2008 to 23.6 in 2030. In the EISA case, mpg for passenger cars grows to 30.2 by 2030. Light

[15] This depreciation rate implies an average service life of about 13 years in the fleet. If this life is too long, we may be overstating the measure of total auto and light truck capital stock and stock growth.

[16] A minor wrinkle is that cars generally decline in efficiency as they age.

[17] An initial estimate yielded 2.5% annual growth in VMT from 2008 to 2030. The *AEO* figure in Table A-7 grows by 1.7% from 2006 to 2030, so we adjusted the miler per vehicle projections downward.

trucks mpg grows from 18.6 to 22.5 in the base, and to 30.8 in the EISA case. Total light-duty fleet mpg grows from 20.9 to 23.3 in the base, and to 30.0 in the EISA case by 2030. The average rate of growth of mpg is 0.5% in the base, and 1.7% in the EISA case.

Total fuel consumption grows from 138.8 billion gallons[18] in 2008 to 180.3 billion in 2030. In the EISA case, fuel consumption dips, but then rises again, to end at 139.0 billion gallons in the EISA case. From the ethanol assumptions (see below), total ethanol supply rises from 9.4 billion gallons in 2008 to 24.1 billion in 2030 in the base, and to 39 billion gallons in the EISA case. The quantity of petroleum based gasoline displaced is about two thirds of this.

Assumptions for fuel consumption in the main LIFT model were derived by first converting gallons of fuel to constant dollars. The difference in total constant dollar consumption in the base and EISA cases was then apportioned between personal consumption use and intermediate use, by reducing all uses by the same percentage. Intermediate use was adjusted by modifying IO coefficients.

Other Assumptions

Two other model variables were modified to capture essential changes in the Motor vehicle industry. These variables are:

1. Input requirements for motor vehicles, and the resulting producer price index of motor vehicles.
2. Equipment investment in the motor vehicle industry.

We assumed that the average factor price of motor vehicles would be about 6 % higher in the EISA case relative to the base by 2015, and assumed this differential would climb to 17% by 2030[19]. The LIFT model calculates prices by adding up unit input costs plus value added. The profits and other capital income equations play the role of the price equations in many other models, responding to demand pressures, changing unit costs, and labor productivity changes in a system of econometrically estimated equations. The prices can be fixed. In this case, the price identity is forced to be satisfied by adjusting the capital income equations (if prices rise, there is more profit). However, since the assumed price

[18] The proper measure is gasoline equivalent gallons (GEG), where the measured quantity of ethanol is reduced by multiplying by its energy coefficient (ethanol has about 2/3 the energy of gasoline). However, the DOT data may measure physical gallons consumed, blended or not.

[19] These cost increases, and the IO coefficient changes necessary to bring them about, were drawn from a National Research Council study (2002).

changes were thought to arise from changes in technology, we specified that several motor vehicle input components would rise more quickly over time. These industry components (with their industry numbers) are listed below:

1. Plastic products (27)
2. Engines and turbines (35)
3. Electrical industrial apparatus (43)
4. Electronic components (48)
5. Motor vehicle parts (50)
6. Other instruments (57)
7. Professional services (77)

These IO coefficient increases in turn stimulate output and employment in the providing industries.

The additional equipment investment in the EISA case was achieved by calculating the implied increase from the base, and incorporating it as an add factor.

Summary of LIFT Variables Affected by Assumptions for CAFE and Ethanol

In regard to both the CAFE and the ethanol provisions of EISA, the development of the submodules served two goals:

1. Extend the capabilities of LIFT to model quantities and detailed variables related to CAFE or ethanol.
2. Provide assumptions for LIFT model variables to affect the model forecast.

The following table summarizes the variables that are changed either by direct assumption, or through calculations from the submodules.

Model Variable	Description of Calculation or Assumption
Price of motor vehicles (pdm49)	Input coefficients of several industries raised, to cause an increase in cost
Price of Agriculture, forestry and fisheries	Raised exogenously, based on calculations described above.
Equipment investment of motor vehicles (eqi34)	Increased directly, for the EISA case, to model investment cost of new fuel-saving technologies.
Equipment investment of Chemicals (eqi12)	Increase to reflect investment in new ethanol capacity.
Personal consumption of gasoline (pce65)	Reduced to reflect reduced consumption due to CAFÉ standards.
IO Coefficient from Agriculture to Chemicals: A(1,23)	Raised to reflect increased use of corn and biomass for ethanol production.

Model Variable	Description of Calculation or Assumption
IO Coefficient from Chemicals to Petroleum refining: A(23,24)	Raised to reflect the increased ethanol content of gasoline.
IO Coefficient from Crude oil to Petroleum refining: A(5,24)	Reduced to reflect the lower crude oil content of gasoline.
IO Coefficients of various industries to Motor vehicles	Raised to model the increased cost of motor vehicles.

3. Simulation Results

Macroeconomic Effects

Table 7 shows summary macroeconomic results. GDP is lower in the EISA case, for all years shown, though not by much. In constant 2000$, real GDP is lower in the EISA case by $180 billion (0.9%) by 2030. Of this difference, $122 billion is comprised of a lower level of personal consumption expenditures, equipment investment is $23 billion lower, and residential and nonresidential structures investment combined is about $9 billion lower. Exports are lower by $66 billion.

The GDP price deflator is higher in the EISA case (by about 1.5% by 2030), and real disposable income is lower, by $116 billion (0.8%). The nominal trade deficit improves by $55 billion in 2030. Oil imports in constant 2000$ are $13.8 billion lower by 2030, a reduction of about 14%.

Most of the reduction in personal consumption and in exports in the EISA case relative to the BAU can be explained by the higher price level, which is due in large part to higher agricultural and motor vehicles prices. Nominal income is increased, but not as much as the increase in the price level, so that real disposable income is generally lower. The personal consumption category with the largest reduction is of course gasoline and oil. Exports are reduced because of the increase in domestic prices relative to foreign prices.

Industry Output and Employment

Table 8 shows selected industry employment and output results (constant 2000$), where significant changes occurred between and EISA and BAU scenarios.

They are summarized in the list below:

- Agriculture, forestry and fisheries (1) – Due to additional requirements of corn and biomass for ethanol production, intermediate flows to chemicals are driving the increase in output for this industry (nearly $5 billion additional output by 2030). Employment increases by 25.6 thousand jobs by 2030.

- Crude petroleum (5) – Output of this industry is reduced, due to reduced crude petroleum requirements for gasoline production. Note that the import share for petroleum was kept the same in both scenarios, so that the reduction in crude petroleum demand is split between imports and domestic production. However, the employment differences for this industry were not significant, and are not shown in the table.
- Other chemicals (23) – This is the industry which includes ethanol production. Output increases by almost $12 billion by 2030. Employment increases by nearly 13 thousand jobs.
- Petroleum refining (24) – Output in this industry falls by $8.9 billion by 2030. This is due to reduced personal consumption and intermediate consumption of gasoline. The employment figures for the petroleum and fuel oil industries are combined, and the total loss in jobs in this combined industry reaches 1.7 thousand by 2030.
- Fuel oil (25) – This includes diesel, and is part of Personal consumption category 65 (Gasoline and oil). It is also affected by the assumed reduction in spending on this category. Output declines by 3.6 billion by 2030.
- Miscellaneous plastic products (27) – This increases by $16 billion by 2030, due to the increased plastics content assumed for Motor vehicles. Employment increases by 25.5 thousand jobs by 2030.
- Electrical industrial apparatus (43) – Output increases by $1.0 billion, and employment by 1.8 thousand, by 2030. This is also a result of the assumed increased content in Motor vehicles.
- Electronic components (48) – This industry output increases by $6.6 billion and jobs by 3.6 thousand by 2030, for the same reason.
- Motor vehicles (49) – Output falls by $15.6 billion, in response to the increase in price. Jobs fall by 17.8 thousand by 2030.
- Other instruments (57) – Output increases (+$2.7 billion) and jobs increase (+4.2 thousand), due to increased content in Motor vehicles.
- Pipelines (63) – Output and jobs decline slightly from the base, due to reduced requirements for transporting crude oil and refined petroleum products.

4. *Conclusions and Further Analysis*

Summary of Results

This paper describes the application of the Inforum *LIFT* model to the analysis of various provisions of the EISA 2007 out to 2030. The BAU («business as usual») scenario attempts to project the path of the economy in the absence of the EISA, and the EISA case assumes that most of the provisions of the EISA take effect, except that the RFS provisions of the act were assumed not to be reached. However, in the EISA case we do assume significant levels in the production in both corn (20 billion gallons) and cellulosic ethanol (12 billion gallons) by 2030, an increase of about 15 billion gallons from the BAU scenario. The CAFE standards specified in EISA were assumed to be maintained, which call for an increase in CAFE for new passenger cars to 35 mpg by 2020, and 30.8 mpg for light trucks. However, due to the relatively small penetration of new vehicles into the existing stock in any given year the average fleet mpg of passenger cars only reaches 26.7 mpg by 2020 and 30.2 mpg by 2030. The figures for light trucks are 25.2 mpg by 2020 and 29.3 mpg by 2030.

Our findings indicate that aggregate GDP and real income will be slightly reduced in the EISA case, due primarily to differences in personal consumption expenditures and exports. Some of the most important assumptions affecting these aggregate results are:

1. An increase in the price index of motor vehicles, in order to produce more fuel-efficient cars.
2. An increase in agricultural prices, due to increased ethanol production.
3. Declines in fuel consumption of automobiles.

Unlike some other studies which found positive macroeconomic impacts of increased ethanol production[20], we did not assume a fall in the world oil price due to reduced U.S. demand for crude petroleum, nor did we assume that ethanol would be cheaper to produce than gasoline, thus bringing down the price of gasoline/ethanol blend. We also assume that the decline in domestic use of crude petroleum is shared proportionally between domestic production of crude oil and imports, which results in a more negative GDP impact than if we had assumed that the decline came solely from imports.

Industries that are positively affected include Agriculture, Other Chemicals and several industries that were assumed to increase their sales to Motor vehicles to achieve increases in fuel efficiency. Industries that were negatively affected include Crude petroleum, Petroleum refining, Fuel oil, Motor vehicles and Pipelines.

We would like to emphasize that the percentage declines in GDP are quite small (0.6% by 2020 and 0.9% by 2030). Non-market considerations, such as the reduction of carbon emissions and the reduced dependence on imported crude oil may outweigh the decline in GDP in policymakers' considerations.

[20] In particular, Dixon, Osborne and Rimmer (2007), and Osborne (2007).

Table 1. Sample of Environment / Energy Bills Introduced into Congress: 2005 to 2008

Introduced			Provisions	Passed	Public Law
April 18, 2005	H.R.1640	Energy Policy Act of 2005	Sets forth an energy research and development program covering: (1) energy efficiency; (2) renewable energy; (3) oil and gas; (4) coal; (5) Indian energy; (6) nuclear matters and security; (7) vehicles and motor fuels, including ethanol; (8) hydrogen; (9) electricity; (10) energy tax incentives; (11) hydropower and geothermal energy; and (12) climate change technology.	August 8, 2005	109-58
January 12, 2007	H.R.6	Energy Independence and Security Act of 2007	Reduce oil dependence through 1) CAFE standards; 2) Renewable Fuel Standard (RFS); 3) Appliance and Lighting Efficiency Standards	December 19, 2007	110-140
January 12, 2007	S.280	Climate Stewardship and Innovation Act of 2007	Aims to reduce GHG emissions with a market-driven system of tradeable allownaces, and support the deployment of climate change related technologies		
July 11, 2007	S.1766	Low Carbon Economy Act of 2007 ("Bingaman-Specter")	Places a cap on GHG emissions, establishes market for emission allowances, and does not allow for foreign credits or international offsets.		
October 18, 2007	S.2191	Climate Security Act of 2008 ("Warner-Lieberman")	Aims to reduce greenhouse gas emissions through a system of traded allowances.	Scheduled for debate	

Table 2. Assumptions and Calculations for Ethanol Production

Line No.		2008	2010	2015	2020	2025	2030
1	**Corn Ethanol Production (billions of gallons)**						
2	Without the EISA	8.6	12.0	14.5	14.8	15.0	15.0
3	With the EISA	8.6	12.0	18.0	19.3	20.0	20.0
4	Ethanol Production Resulting from EISA	0.0	0.0	3.5	4.5	5.0	5.0
5							
6	**Cellulosic Ethanol Production (billions of gallons)**						
7	Without the EISA	0.0	0.0	0.2	1.2	2.1	2.1
8	With the EISA	0.0	0.0	0.2	1.2	5.5	12.0
9	Ethanol Production Resulting from EISA	0.0	0.0	0.0	0.0	3.4	9.9
10							
11	**Total Ethanol Production (billions of gallons)**						
12	Without the EISA	8.6	12.0	14.7	16.0	17.1	17.1
13	With the EISA	8.6	12.0	18.2	20.5	25.5	32.0
14	Ethanol Production Resulting from EISA	0.0	0.0	3.5	4.5	8.4	14.9
15							
16	**Corn Ethanol Production Capacity (without EISA)**						
17	Number (115 in existence plus 79 under construction)	140	175	200	200	202	202
18	Average Production Per Plant (millions of gallons)	70	72	81	87	90	90
19	Annual Production Capacity (billions of gallons)	9.8	12.6	16.2	17.4	18.2	18.2
20	Capacity Utilization Rate without EISA (%)	87.8%	95.2%	89.5%	85.1%	82.5%	82.5%
21	Incremental Capital Cost (2007$ per gallon of capacity)	1.45	1.35	1.33	1.30	1.30	1.30
22	Investment (Millions of 2007$)	6244.6	1674.0	530.0	520.0	0.0	0.0
23	**Corn Ethanol Production Capacity (with EISA)**						
24	Number (115 in existence plus 79 under construction)	140	194	230	254	262	267
25	Average Production Per Plant (millions of gallons)	70	72	81	87	90	90
26	Annual Production Capacity (billions of gallons)	9.8	14.0	18.6	22.1	23.6	24.0
27	Capacity Utilization Rate with EISA (%)	87.8%	85.9%	96.6%	87.3%	84.8%	83.2%
28	Incremental Capital Cost (2007$ per gallon of capacity)	1.45	1.35	1.33	1.30	1.30	1.30
29	Investment (Millions of 2007$)	6244.6	3041.6	1656.2	881.4	0.0	117.0
30	**Corn Ethanol Production Capacity (As a Result of EISA)**						
31	Change in the number of plants	0	19	30	54	60	65
32	Change in Annual Production Capacity (billions of gallons)	0.0	1.4	2.4	4.7	5.4	5.9
33							
34	**Cellulosic Ethanol Production Capacity (without EISA)**						
35	Number (None in existence)	0	0	3	17	31	28
36	Average Production Per Plant (millions of gallons)	0	0	75	87	90	99
37	Annual Production Capacity (billions of gallons)	0.0	0.0	0.2	1.5	2.8	2.8
38	Capacity Utilization Rate without EISA (%)	0.0%	0.0%	88.9%	83.8%	75.3%	75.8%
39	Incremental Capital Cost (2007$ per gallon of capacity)	7.2	6.5	5.6	4.7	3.0	3.0
40	Investment (Millions of 2007$)	0.0	0.0	590.6	2180.2	0.0	0.0
41	**Cellulosic Ethanol Production Capacity (with EISA)**						
42	Number (None in existence)	0	0	3	17	65	130
43	Average Production Per Plant (millions of gallons)	0	0	75	87	90	99
44	Annual Production Capacity (billions of gallons)	0	0	0.2	1.5	5.9	12.9
45	Capacity Utilization Rate with EISA (%)	0.0%	0.0%	88.9%	81.1%	94.0%	93.2%
46	Incremental Capital Cost (2007$ per gallon of capacity)	7.2	6.5	5.6	4.7	3.0	3.0
47	Investment (Millions of 2007$)	0.0	0.0	590.6	2180.2	5928.7	2235.0
48	**Cellulosic Ethanol Production Capacity (As a Result of EISA)**						
49	Change in the Number of Plants	0	0	0	0	34	102
50	Change in Annual Production Capacity (billions of gallons)	0.0	0.0	0.0	0.0	3.1	10.1
51							
52	**Corn Market Assumptions**						
53	Acres planted (millions)	88.0	93.0	91.5	92.0	92.0	92.0
54	Acres harvested	80.5	85.6	84.1	84.6	84.6	84.6
55	Yield/Harvested Acre (bushels)	148.4	159.3	169.3	179.3	184.7	190.0
56	Corn Production (bil bu)	11.9	13.6	14.2	15.2	15.6	16.1
57	Ethanol Conversion Rate (gal/bu)	2.91	2.93	2.96	2.99	3.04	3.10
58	Corn Ethanol Yield (gal/acre)	432.2	465.9	500.6	535.7	560.9	589.0
59							
60	**Ethanol Imports (billions of gallons) (w & wo EISA)**	0.800	0.899	2.400	3.200	5.000	7.000

Table 3. Ethanol and Corn Model Results

	2008	2010	2015	2020	2025	2030	08-30	08-20	20-30
Total Ethanol Production	8.6	12.0	14.7	16.0	17.1	17.1	3.2	5.3	0.6
	8.6	12.0	18.2	20.5	25.5	32.0	6.2	7.5	4.6
Ethanol Imports	0.8	0.9	2.4	3.2	5.0	7.0	10.4	12.2	8.1
	0.8	0.9	2.4	3.2	5.0	7.0	10.4	12.2	8.1
Ethanol Supply	9.4	12.9	17.1	19.2	22.1	24.1	4.4	6.2	2.3
	9.4	12.9	20.6	23.7	30.5	39.0	6.7	8.0	5.1
Ethanol subsidy rate ($/gal)	0.51	0.51	0.51	0.51	0.51	0.51	0.0	0.0	0.0
	0.51	0.51	0.51	0.51	0.51	0.51	0.0	0.0	0.0
Total Subsidy Paid (mil$)	4386	6120	7497	8180	8721	8721	3.2	5.3	0.6
	4386	6120	9279	10455	13005	16320	6.2	7.5	4.6
Corn Supply & Disposition (bil bu)									
Beginning Stocks	1.90	0.55	0.76	0.88	1.81	1.72	-0.5	-6.2	6.9
	1.90	0.55	0.75	0.87	1.83	1.32	-1.6	-6.2	4.2
Production	11.86	13.64	14.24	15.17	15.62	16.08	1.4	2.1	0.6
	11.86	13.64	14.24	15.17	15.62	16.08	1.4	2.1	0.6
Imports	0.01	0.01	0.01	0.01	0.01	0.01	0.0	0.0	0.0
	0.01	0.01	0.01	0.01	0.01	0.01	0.0	0.0	0.0
Supply	11.87	13.65	14.26	15.19	15.64	16.09	1.4	2.1	0.6
	11.87	13.65	14.26	15.19	15.64	16.09	1.4	2.1	0.6
Feed and Residual	5.45	5.12	5.11	5.49	5.76	6.49	0.8	0.1	1.7
	5.45	5.12	4.52	4.73	4.97	5.77	0.3	-1.2	2.0
Food, Seed & Industrial	5.50	6.60	7.41	7.45	7.44	7.34	1.3	2.6	-0.2
	5.50	6.60	8.59	8.96	9.08	8.95	2.2	4.2	0.0
Ethanol	2.95	4.10	4.90	4.95	4.94	4.84	2.3	4.4	-0.2
	2.95	4.10	6.09	6.46	6.58	6.45	3.6	6.7	0.0
Non-Ethanol FS&I	2.55	2.50	2.50	2.50	2.50	2.50	-0.1	-0.2	0.0
	2.55	2.50	2.50	2.50	2.50	2.50	-0.1	-0.2	0.0
Domestic Use	10.95	11.73	12.52	12.95	13.19	13.83	1.1	1.4	0.7
	10.95	11.73	13.11	13.69	14.05	14.72	1.4	1.9	0.7
Exports	2.15	1.72	1.74	2.08	2.26	2.65	0.9	-0.3	2.4
	2.15	1.72	1.14	1.33	1.45	1.87	-0.6	-3.9	3.5
Total Use	13.10	13.45	14.25	15.03	15.46	16.48	1.0	1.2	0.9
	13.10	13.45	14.25	15.02	15.50	16.60	1.1	1.1	1.0
Ending Stocks	0.67	0.75	0.76	1.03	1.99	1.33	3.2	3.7	2.6
	0.67	0.75	0.76	1.04	1.97	0.82	0.9	3.8	-2.4
Share of Corn for Ethanol (percent)	24.9	30.0	34.4	32.6	31.6	30.1	0.9	2.3	-0.8
	24.9	30.0	42.7	42.5	42.1	40.1	2.2	4.6	-0.6

Table 4. Calculated Effect of Ethanol Production Increase on Corn and Agriculture Prices

			2012	2015	2020	2025	2030
Corn Production for Ethanol (bil bu)	BAU		4.5	4.9	5.0	4.9	4.8
	EISA		4.5	6.1	6.5	6.6	6.5
	Difference		0.0	1.2	1.5	1.6	1.6
Total Corn Production (bil bu)			13.6	14.2	15.2	15.6	16.1
Ethanol Demand Shift (percent of total)			0.0%	8.3%	9.9%	10.5%	10.0%
Assumed percentage increase in corn price per one percentage point increase in corn use for ethanol		**0.42**					
Percentage increase in corn price			0.0%	3.5%	4.2%	4.4%	4.2%
Share of corn and soybeans in total Agriculture, forestry and fisheries (2006)		**0.116**					
Estimated percent increase in Agriculture, forestry and fisheries price			0	0.40%	0.48%	0.51%	0.49%

Table 5. Assumptions and Calculation of Improved Energy Efficiency in the Auto and Light Truck Fleet as a Result of CAFE Provisions

Line No.		2008	2010	2015	2020	2025	2030
1	Increase in the price of autos/lt. trucks (index)	1.01	1.04	1.06	1.08	1.11	1.15
2	Increase in annual growth in auto ind. equip. investment to						
3	incorporate new technologies (percentage point)	0.00	0.80	0.80	0.80	0.80	0.80
4							
5	**CAFÉ Mix of Fleet (Pre-EISA:Post-EISA)**						
6	Pre EISA fleet (existing technologies) (x00 percent)	1.00	0.90	0.65	0.40	0.15	0.10
7	Post EISA fleet (new technologies) (x00 percent)	0.00	0.10	0.35	0.60	0.85	0.90
8							
9	**Fleet Mix (Autos:Light Trucks)**						
10	Autos (x00 percent)	0.58	0.59	0.62	0.64	0.65	0.65
11	Light Trucks (x00 percent)	0.42	0.41	0.38	0.36	0.35	0.35
12							
13	**Fleet Mix (100 unit example)**						
14	Autos						
15	Old Café	58.00	53.10	40.30	25.60	9.75	6.60
16	New Café	0.00	5.90	21.70	38.40	55.25	59.40
17	Light Trucks						
18	Old Café	42.00	36.90	24.70	14.40	5.25	3.40
19	New Café	0.00	4.10	13.30	21.60	29.75	30.60
20							
21	**CAFÉ Increase**						
22	Autos (mpg avg.)	25.00	26.82	31.36	35.00	35.00	35.00
23	Light Trucks (mpg avg.)	22.00	23.60	27.60	30.80	30.80	30.80

Table 6. Results of Vehicles Submodule

	2008	2010	2015	2020	2025	2030	08-30	08-20	20-30
Automobile Industry									
Factory price index	1.25	1.31	1.47	1.62	1.77	1.92	2.0	2.2	1.7
	1.25	1.32	1.54	1.76	2.00	2.26	2.7	2.9	2.5
Investment (billions of 2007$)	10.8	14.0	16.6	18.6	22.0	28.4	4.5	4.7	4.3
	10.8	14.1	17.0	20.3	24.6	33.0	5.2	5.4	5.0
Fleet Characteristics									
Passenger Cars									
Number of Vehicles	140.7	146.0	163.9	181.5	198.7	218.1	2.0	2.1	1.9
	140.7	146.0	163.4	181.1	198.6	218.6	2.0	2.1	1.9
Avg. Miles/Vehicle	12.7	12.9	13.1	13.2	13.4	13.5	0.3	0.3	0.2
	12.6	12.8	12.9	12.9	13.1	13.2	0.2	0.2	0.2
Vehicle Miles Traveled	1784.1	1877.3	2144.9	2400.0	2653.0	2941.5	2.3	2.5	2.1
	1779.3	1861.9	2102.7	2342.7	2591.9	2891.7	2.2	2.3	2.1
Miles Per Gallon	22.5	22.6	22.8	23.1	23.3	23.6	0.2	0.2	0.2
	22.5	22.7	24.3	26.7	28.7	30.2	1.4	1.4	1.2
CAFE Standard for Cars	25.0	25.0	25.0	25.0	25.0	25.0	0.0	0.0	0.0
	25.0	26.8	31.4	35.0	35.0	35.0	1.5	2.8	0.0
Fuel Consumption (GEG)	79.4	83.2	94.1	104.1	113.7	124.6	2.1	2.3	1.8
	79.2	81.9	86.7	87.8	90.3	95.8	0.9	0.9	0.9
Light Trucks									
Number of Vehicles	100.3	101.5	106.7	110.8	113.6	116.9	0.7	0.8	0.5
	100.3	101.4	106.3	110.4	113.2	116.5	0.7	0.8	0.5
Avg. Miles/Vehicle	11.0	11.0	10.9	10.8	10.8	10.7	-0.1	-0.1	-0.1
	11.0	11.0	10.9	10.8	10.8	10.7	-0.1	-0.1	-0.1
Vehicle Miles Traveled	1101.1	1111.5	1163.0	1201.2	1225.8	1254.6	0.6	0.7	0.4
	1101.1	1111.1	1159.0	1197.0	1221.7	1251.3	0.6	0.7	0.4
Miles Per Gallon	18.6	19.3	20.5	21.4	22.0	22.5	0.9	1.2	0.5
	18.6	19.5	22.1	25.2	27.6	29.3	2.1	2.6	1.5
CAFE Standard for Light Trucks	22.0	22.0	22.0	22.0	22.0	22.0	0.0	0.0	0.0
	22.0	23.6	27.6	30.8	30.8	30.8	1.5	2.8	0.0
Fuel Consumption (GEG)	59.2	57.7	56.6	56.1	55.6	55.8	-0.3	-0.4	-0.1
	59.2	57.1	52.5	47.5	44.2	42.7	-1.5	-1.8	-1.1
Light-duty Vehicles, Total									
Number of Vehicles	247.9	254.7	278.6	301.1	321.9	345.4	1.5	1.6	1.4
	247.9	254.6	277.7	300.3	321.4	345.6	1.5	1.6	1.4
Avg. Miles/Vehicle	11.7	11.8	11.9	12.0	12.1	12.2	0.2	0.2	0.2
	11.7	11.7	11.8	11.8	11.9	12.0	0.1	0.1	0.2
Vehicle Miles Traveled	2898.0	3002.1	3322.8	3617.6	3896.7	4215.6	1.7	1.9	1.5
	2893.2	2986.3	3276.4	3556.1	3831.5	4162.5	1.7	1.7	1.6
Miles Per Gallon	20.9	21.3	22.0	22.5	23.0	23.3	0.5	0.6	0.3
	20.9	21.4	23.5	26.2	28.4	30.0	1.7	1.9	1.4
Fuel Consumption (GEG)	138.8	141.1	151.0	160.5	169.6	180.7	1.2	1.2	1.2
	138.6	139.3	139.4	135.6	134.8	138.7	0.0	-0.2	0.2
Gasoline Summary (mil gal)									
Total Fuel for Light Duty Vehicles	138.8	141.1	151.0	160.5	169.6	180.7	1.2	1.2	1.2
	138.6	139.3	139.4	135.6	134.8	138.7	0.0	-0.2	0.2
Ethanol Supply	9.4	12.9	17.1	19.2	22.1	24.1	4.4	6.2	2.3
	9.4	12.9	20.6	23.7	30.5	39.0	6.7	8.0	5.1
Gasoline Replaced by Ethanol	6.2	8.5	11.3	12.7	14.5	15.9	4.4	6.2	2.3
	6.2	8.5	13.6	15.6	20.1	25.7	6.7	8.0	5.1
Petroleum Based Gasoline	132.6	132.6	139.7	147.8	155.1	164.8	1.0	0.9	1.1
	132.4	130.8	125.8	120.0	114.7	113.1	-0.7	-0.8	-0.6
Gasoline Consumption (bil 2007$)	372.4	378.7	405.1	430.6	455.3	484.9	1.2	1.2	1.2
	372.0	373.8	374.1	363.9	361.7	372.5	0.0	-0.2	0.2
Gasoline Consumption (cu$)	412.6	360.4	340.3	377.9	400.4	442.0	0.3	-0.7	1.6
	412.0	355.7	314.2	319.2	318.0	339.4	-0.9	-2.1	0.6

Table 7. Macroeconomic Summary

	2008	2010	2015	2020	2025	2030	08-30	08-20	20-30
REAL GDP by FINAL DEMAND CATEGORY (Billions of chained 2000 dollars)									
Gross Domestic Product	11650	12361	14320	15936	17906	20439	2.6	2.6	2.5
	-14	-45	-155	-97	-129	-180	0.0	0.0	0.0
Personal Consumption Expenditures	8392	8860	10285	11403	12716	14080	2.4	2.6	2.1
	-12	-41	-148	-97	-109	-122	0.0	-0.1	0.0
Gross Private Fixed Investment	1716	1929	2351	2598	3018	3665	3.5	3.5	3.5
	-2	-7	-35	0	-15	-23	0.0	0.0	-0.1
Nonresidential Structures	288	365	387	388	419	502	2.6	2.5	2.6
	0	-2	-5	1	-2	-3	0.0	0.0	-0.1
Equipment Investment	1025	1128	1315	1511	1836	2296	3.7	3.3	4.3
	-1	-5	-17	-3	-13	-19	0.0	0.0	-0.1
Residential Investment	413	430	640	715	818	961	3.9	4.7	3.0
	0	0	-13	0	-4	-6	0.0	0.0	-0.1
Real Net Exports	-498	-469	-369	-128	129	764			
	0	3	26	-3	-16	-58			
Exports	1518	1764	2467	3408	4539	6050	6.5	7.0	5.9
	0	0	-2	-16	-33	-66	-0.1	0.0	-0.1
Imports	2017	2233	2836	3536	4410	5286	4.5	4.8	4.1
	0	-3	-28	-13	-17	-8	0.0	0.0	0.0
Government	2078	2103	2181	2283	2397	2504	0.9	0.8	0.9
	0	-1	0	-2	0	-1	0.0	0.0	0.0
Gross Domestic Product, bil cu$	14252	15672	19915	24304	30298	38004	4.6	4.5	4.6
	-18	-57	-214	-13	71	230	0.0	0.0	0.1
GDP Deflator	122.3	126.8	139.1	152.5	169.2	185.9	1.9	1.9	2.0
	0.0	0.0	0.0	0.9	1.6	2.8	0.1	0.0	0.1
Unemployment Rate	5.8	5.9	3.6	4.5	5.5	5.9	0.0	-2.1	2.6
	0.1	0.3	0.9	0.3	0.3	0.3	0.1	0.4	-0.1
Real Disp Income, bil 00$	8765	9220	10800	11977	13324	14922	2.4	2.6	2.2
	-13	-44	-162	-100	-107	-116	0.0	-0.1	0.0
Trade Balance	-833	-824	-902	-943	-1060	-748	-0.5	1.0	-2.3
	-1	3	41	30	48	55	-0.3	-0.3	-0.4
Oil Imports	98.7	90.7	92.1	90.5	93.5	101.8	0.1	-0.7	1.2
	0.0	0.1	-3.0	-4.7	-8.2	-13.8	-0.7	-0.4	-0.9

Table 8. Output and Employment for Selected Industries

	2008	2010	2015	2020	2025	2030	08-30	08-20	20-30
Output (billions of constant 2000$)									
1 Agriculture, forestry and fisheries	397.6	416.3	464.1	495.0	516.7	562.4	1.6	1.8	1.3
	-0.2	-0.5	-0.2	0.2	1.9	4.8	0.0	0.0	0.1
5 Crude petroleum	81.4	89.3	85.9	88.6	81.6	68.7	-0.8	0.7	-2.5
	0.0	0.1	-2.4	-3.9	-5.9	-7.3	-0.5	-0.4	-0.7
23 Other chemicals	246.3	263.4	309.0	332.0	348.1	392.4	2.1	2.5	1.7
	-0.1	-0.3	2.9	4.2	7.2	11.8	0.1	0.1	0.2
24 Petroleum refining	259.8	259.3	266.1	270.8	274.1	278.5	0.3	0.3	0.3
	0.1	0.5	-2.3	-5.7	-7.8	-8.9	-0.1	-0.2	-0.1
25 Fuel oil	74.9	75.2	79.0	82.0	86.6	91.7	0.9	0.8	1.1
	0.0	-0.2	-1.2	-2.2	-3.0	-3.6	-0.2	-0.2	-0.1
27 Plastic products	153.3	163.5	193.0	215.1	241.0	288.6	2.9	2.9	3.0
	-0.1	0.2	2.5	6.7	10.6	16.0	0.3	0.3	0.2
43 Electrical industrial apparatus	33.2	34.5	37.5	38.9	40.2	47.4	1.6	1.3	2.0
	0.0	0.1	0.5	0.9	0.8	1.0	0.1	0.2	0.0
48 Electronic components	221.7	241.8	296.7	343.4	387.0	468.9	3.5	3.7	3.2
	-0.1	0.0	1.0	3.4	4.7	6.6	0.1	0.1	0.0
49 Motor vehicles	292.6	314.7	366.6	397.1	435.4	499.0	2.5	2.6	2.3
	-0.4	-1.8	-6.3	-6.2	-10.6	-15.6	-0.1	-0.1	-0.2
57 Other instruments	86.2	96.5	120.5	146.7	177.8	229.6	4.6	4.5	4.6
	-0.1	0.1	0.4	1.4	2.4	2.7	0.1	0.1	0.0
63 Pipelines	8.0	8.1	8.7	9.5	10.3	11.5	1.6	1.4	1.9
	0.0	0.0	-0.1	-0.3	-0.4	-0.4	-0.2	-0.2	-0.1
Employment (thousands)									
1 Agriculture, forestry, and fisheries	3824.5	3832.3	3752.1	3485.4	3194.0	3000.6	-1.1	-0.8	-1.5
	-1.2	-4.8	-3.0	1.2	10.0	25.6	0.0	0.0	0.1
23 Other chemicals	441.9	460.6	488.4	467.8	436.7	428.6	-0.1	0.5	-0.9
	-0.1	-0.4	3.0	5.9	8.0	12.8	0.1	0.1	0.2
24 Petroleum refining & fuel oil	106.6	97.8	84.1	70.3	59.0	49.6	-3.4	-3.4	-3.4
	0.0	0.1	-0.7	-1.5	-1.7	-1.7	-0.1	-0.2	-0.1
27 Plastic products	629.2	608.3	576.7	522.0	480.6	468.6	-1.3	-1.5	-1.1
	-0.2	0.0	6.6	15.6	20.4	25.5	0.2	0.2	0.2
43 Electrical industrial apparatus	156.0	146.9	124.4	104.0	88.4	85.1	-2.7	-3.3	-2.0
	0.0	0.1	1.5	2.5	1.8	1.8	0.1	0.2	0.0
48 Electronic components	535.6	397.9	262.4	213.1	204.2	233.9	-3.7	-7.4	0.9
	-0.3	-0.1	1.3	3.4	3.3	3.6	0.1	0.1	0.0
49 Motor vehicles	474.0	493.2	544.4	549.3	555.7	580.0	0.9	1.2	0.5
	-0.4	-2.2	-9.2	-8.1	-13.4	-17.8	-0.1	-0.1	-0.2
57 Other instruments	255.6	277.4	300.7	308.4	312.3	329.4	1.2	1.6	0.7
	-0.1	0.1	0.7	3.0	3.8	4.2	0.1	0.1	0.0
63 Pipelines	9.6	9.1	8.5	8.1	7.8	7.7	-1.0	-1.4	-0.6
	0.0	0.0	-0.1	-0.2	-0.3	-0.3	-0.2	-0.2	-0.1
Total Employment	148166.4	151245.5	160114.8	162126.2	165845.5	171798.5	0.7	0.8	0.6
	-127.1	-432.7	-1466.5	-465.7	-517.1	-493.7	0.0	0.0	0.0

Appendix A. Calibration of LIFT to the Annual Energy Outlook

As described in the text, the *LIFT* model was calibrated to this revised AEO for the EISA case. Part of this calibration was at the macroeconomic level, and part included detailed calibration of energy coefficients. At the macroeconomic level, the calibration included the following variables:

1. *Population and labor force* – Population projections are made by detailed age group in *LIFT*. However, total population and labor force can be controlled to a specified level.
2. *Real government spending* – Government spending in *LIFT* is composed of many detailed categories, for federal defense, federal nondefense, state and local (S&L) education, S&L health, and S&L other. These can all be fixed in real terms. The model calculates the nominal values, using government spending price deflators.
3. *Total real exports* – Instead of using the INFORUM Bilateral Trade Model (BTM), exports are left endogenous. Add factors are applied to bring the total in line with AEO. This method allows exports to respond to relative prices.
4. *Crude oil price, natural gas price and coal price* – The AEO presents these prices in real terms, i.e., divided by the GDP deflator. Once the path of the GDP deflator has settled down, these price assumptions can be more finely tuned.
5. *Total real personal consumption* – This total can be specified exogenously. However, this removes much of the model's behavioral response. Instead, we guide the consumption total with add factors on the personal savings rate.
6. *Real investment* – The AEO total for real investment consists of detailed categories of equipment investment, residential construction and nonresidential construction in *LIFT*.
7. *Total real imports* – Individual import equations for each commodity relate imports to domestic demand and relative foreign to domestic prices. Aggregate fixes can be applied, but one must be careful not to make imports of any commodity greater than domestic demand, or this will result in negative output.
8. *Crude oil imports* – Crude oil imports are targeted by fixing the import share.
9. *Labor productivity growth* – Aggregate labor productivity growth in LIFT is a weighted average of productivity growth by industry. Industry variables must be adjusted to adjust the total. The aggregate growth is also affected by industry mix, so that a simulation with higher exports will have faster productivity growth than a simulation with low exports, since productivity growth in the tradeable sectors tends to be faster.

10. *Employment and unemployment* – Since employment and productivity are integrally related, it is useful to hit the productivity targets first, and then make minor modifications to employment. The aggregate unemployment rate can also be calibrated by altering the multiple job adjustment, which relates industry employment to household employment.
11. *Real disposable income* – This can be adjusted most effectively by adjusting the personal tax rate. However, the growth rate of the components of personal income are also important.
12. *GDP price level* – The aggregate price level is a result of a myriad of factors, including individual price fixes, labor compensation, corporate profits, proprietors' income, and capital consumption allowances. These value added categories can be adjusted through the use of aggregate fixes.

Calibration of energy consumption aggregates was achieved partly through the adjustment of IO coefficients, and partly through the adjustment of personal and government consumption of energy. Some individual IO flows are shown explicitly in the AEO tables, such as the consumption of coal for electricity generation. Total electricity consumption (residential, commercial, industrial) is calibrated first, given the macroeconomic, consumer and industry forecast. Then the coal to electricity coefficient A(3,66) is adjusted to bring coal use by electric utilities into agreement with the AEO[21].

Transportation energy consumption was calibrated by adjusting energy input coefficients in the transportation sectors of *LIFT* (59-64). Industrial energy consumption was calibrated in a similar way, adjusting energy coefficients in the industrial sectors (1-58). Commercial energy consumption includes consumption by trade, services (69-87) and government. Residential energy consumption was calibrated by adjusting personal consumption of energy categories.

A carbon emission calculation submodule was also constructed that relates emissions to energy use. The growth of carbon emissions by major sector was scrutinized as an extra check on the success of the energy flow calibrations. Calibration of the model involving the production of ethanol and the effect of CAFE standards on consumption of motor fuels is discussed in text.

[21] This coal to electricity IO coefficient is largely a function of the mix of generation methods (coal, natural gas, oil, hydro, nuclear, wind, solar, etc.) used. The AEO shows the coal coefficient declining until 2018, as more natural gas capacity comes online, but then rising again as natural gas is expected to increase in cost.

Appendix B. 97 LIFT Commodity Sectors

Appendix C. Glossary and Conversions

AEO	Annual Energy Outlook
BAU	Business as Usual
CAFE	Corporate Average Fuel Economy
DOE	Department of Energy
EISA	Energy Independence and Security Act
INFORUM	Interindustry Forecasting at the University of Maryland
LIFT	Long-term Interindustry Forecasting Tool
mpg	Miles per gallon
NEMS	National Energy Modeling System
NREL	National Renewable Energy Laboratory
PCE	Personal Consumption Expenditures
RFS	Renewable Fuels Standard
USDA	U.S. Department of Agriculture
VMT	Vehicle miles traveled

Conversions

Acre	1 Acre = .4047 hectare
Barrel	1 Barrel = 42 U.S. gallons
Bushel	.0352 cubic meters, or 35.24 liters
Gallon	1 U.S. Gallon = 3.785 liters
Mile	1 U.S. Mile = 1.609 kilometers

References

Baker Allen and Steven Zahniser (2006). Ethanol Reshapes the Corn Market. *Amber Waves*, 4(2), April, ERS/USDA, <http://www.ers.usda.gov/AmberWaves/April06/pdf/EthanolFeatureApril06.pdf>.

Collins Keith (2008) The Role of Biofuels and Other Factors in Increasing Farm and Food Prices. June 19, <http://www.foodbeforefuel.org/files/Role%20of%20Biofuels%206-19-08.pdf>.

DiPardo Joseph, Outlook for Biomass Ethanol Production and Demand. EIA, <http://tonto.eia.doe.gov/ftproot/features/biomass.pdf>.

Dixon Peter, Stefan Osborne and Maureen Rimmer (2007). The Economy-wide Effects in the United States of Replacing Crude Petroleum with Biomass. January, <https://www.gtap.agecon.purdue.edu/resources/download/3358.pdf>.

Eathington Liesl and David Swenson (2007). Dude, Where's My Corn? Constraints on the Location of Ethanol Production in the Corn Belt. Department of Economics, Iowa State University, March.

Food and Agricultural Policy Research Institute (2008). U.S. Baseline Briefing Book, Projections for Agricultural and Biofuel Markets. University of Missouri-Columbia, FAPRI-MU Report #03-08, March, <http://www.fapri.missouri.edu/outreach/publications/2008/FAPRI_MU_Report_03_08.pdf>.

Glauber Joseph (2008). Statement before the Committee on Energy and Natural Resources, United States Senate. June 12, <http://www.usda.gov/oce/newsroom/archives/testimony/2008/GlauberSenate061208.pdf>.

Hahn Robert and Croline Cecot (2007). The Benefits and Costs of Ethanol. Working Paper 07-17, AEI-Brookings Joint Center for Regulatory Studies, November.

Koplow Doug (2007). Biofuels at What Cost? Government Support for Ethanol and Biodiesel in the United States: 2007 Update. Report prepared for the Blobal Studies Initiative of the International Institute for Sustainable Development, Geneva, Switzerland, October.

McAloon Andrew, Frank Taylor and Winnie Lee, Determining the Cost of Producing Ethanol from Corn Starch and Lignocellulosic Feedstocks. National Renewable Energy Laboratory NREL/TP-580-28893, <http://www.nrel.gov/docs/fy01osti/28893.pdf>.

McPhail Lihong Lu and Babcock Bruce A. (2008). Short-run Price and Welfare Impacts of Federal Ethanol Policies. Center for Agricultural and Rural Development, Iowa State University, Working Paper 08-WP 468, June, <http://www.card.iastate.edu/publications/DBS/PDF>Files/08wp468.pdf>.

Meade Douglas (2001). The LIFT Model. Inforum Working Paper, June, <http://www.inforum.umd.edu/papers/wp/wp/2001/wp01002.pdf>.

Osborne Stefan (2007). Energy in 2020: Assessing the Economic Effects of Commercialization of Cellulosic Ethanol. Manufacturing and Services Competitiveness Report, U.S. Department of Commerce, International Trade Administration, November, <http://www.ita.doc.gov/media/Publications/pdf>/cellulosic2007.pdf>.

Peters David J. (2007). Understanding Ethanol Plant Economics: Will Boom Turn Bust?. University of Nebraska, Institute of Agriculture and Natural Resources, RD-2007-08-1, August, <http://agecon.unl.edu/peters/pubs/rd-2007-08-1.pdf>.

Schnepf Randy (2008). High Agricultural Commodity Prices: What Are the Issues?. Congressional Research Service, CRS Report for Congress RL34474, May 8, <http://www.fremarcoop.com/images/E0016301/CRS_CommodityPrices.pdf>.

Schoonover Heather and Mark Muller (2006). Staying Home: How Ethanol Will Change U.S. Corn Exports. December, Institute for Agriculture and Trade Policy, <http://www.agobservatory.org/library.cfm?refid=96658>.

Shapouri Hosein and Andrew McAloon, The 2001 Net Energy Balance of Corn-Ethanol. ERS Report, <http://www.usda.gov/oce/reports/energy/net_energy_balance.pdf>.

Shapouri Hosein and Paul Gallagher (2005). USDA's 2002 Ethanol Cost of Production Survey. USDA, July, <http://www.ncga.com/ethanol/pdf>s/031506USDACostOfProduction.pdf>.

Sissine Fred (Coordinator) (2007). Energy Independence and Security Act of 2007: A Summary of Major Provisions. Congressional Research Service, CRS Report for Congress RL34294, December, <http://energy.senate.gov/public/_files/RL342941.pdf>.

Swenson David (2006). Input-Outrageous: The Economic Impacts of Modern Biofuels Production. Department of Economics, Iowa State University, June, <http://www.nercrd.psu.edu/Biofuels/Swenson.pdf>.

Tokgoz Simla *et al.* (2007). Emerging Biofuels: Outlook of Effects on U.S. Grain, Oilseed and Livestock Markets. Center for Agricultural and Rural Development, Iowa State University, July, , at <http://www.card.iastate.edu/publications/DBS/PDF>Files/07sr101.pdf>.

Transportation Research Board, National Research Council (2002). Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards. National Academy Press, Washington, D.C.

Westcott Paul (2007). Ethanol Expansion in the United States: How Will the Agricultural Sector Adjust?. ERS Report FSD-07D-01, May.

U.S. Department of Agriculture (2008). USDA Agricultural Projections to 2017. Office of the Chief Economist, February, <http://www.ers.usda.gov/publications/oce081/>.

U.S. Department of Energy, Energy Information Administration (2008). Annual Energy Outlook 2008. June, Washington, D.C., <http://www.eia.doe.gov/oiaf/aeo/>.

Yacobucci Brent D. and Tom Capehart (2008). Selected Issues Related to an Expansion of the Renewable Fuel Standard (RFS). Congressional Research Service, CRS Report for Congress RL34265, March, <http://assets.opencrs.com/rpts/RL34265_20071203.pdf>.

THE ESTIMATION OF EMBODIED ENERGY AND DISCHARGED POLLUTANTS IN CHINA'S IMPORT & EXPORT

Li Shantong, He Jianwu
Development Research Center of the State Council, P.R. China

1. Introduction

China has enjoyed a very high economic growth rate since its reform and opening to the outside world in the late 70's. Its growth has been driven mainly by high investment and the rapid growth of foreign trade since the late 90's. But the rapid growth of the economy and trade has been accompanied by high energy consumption and also, to a certain extent, the rapid growth of energy intensive sectors in the recent years of industrialization (See Appendix 1). In the meantime in the contemporary globalized world there is new concern for environmental issues, leading to a need for further study and new considerations regarding investment and trade.

In recent years, with the development of world economic integration, global environmental problems have becoming increasingly important issues. These include exhausted natural resources, damage to the ozone layer and air pollution all posing a tough challenge to sustainable human development and survival conditions in a scenario where the international commodity trade, by affecting the consumption of natural resources and having environmental effects, constitutes one of the focuses of the debate.

The international commodity trade, on the one hand, brings the trans border allocation of energy and resources (through the direct import & export of energy and resources); on the other hand, it also brings a trans border reallocation of the carriers of energy and resources, i.e. embodied energy and resources (the import & export of the energy and resources needed to produce products in the production process). Though adequate data for the latter could not be found in direct trade statistics, it greatly influences energy and the environment in various countries, attracting considerable public attention.

So-called «embodied energy», indicates the total energy consumed in the entire production process of a product, including in its upper reaches of processing, manufacturing and shipment. Obviously, the embodied

Maurizio Grassini and Rossella Bardazzi (edited by), *Energy Policy and International Competitiveness*,
ISBN 978-88-6453-040-6 (print) ISBN 978-88-6453-043-7 (online)

energy consumed in production is more than the direct energy used to make a product. It is worth noting that embodied energy indicates the energy consumed in the entire production process of a product in its upper reaches of processing, manufacturing and shipment only , it does not include energy produced in itself and energy consumed in the down reaches of utility. Take the manufacture of a car for example, energy is not only consumed directly in the process of assembling auto parts, but energy is also consumed in the process of making car tyres – rubber, and in the process of producing windscreens etc. In brief, the energy embodied in making a product includes the total energy consumed in the upper reaches of the manufacturing process.

In the same way as above, «embodied pollution» indicates that the embodied emission of SO_2 includes total emission in the upper reaches of processing, manufacturing and shipment of a product; the embodied emission of SO_2 is more than the direct emission by a product at its final consumption point.

2. Overview of literature

In recent years, with the rapid growth of foreign trade, much attention has been paid by the international community to the issues of energy safety and climate change, which have gradually become more important. Early studies focused on energy consumption in the domestic economy and trade and environment pollution in some EU countries and Japan. Since then the methodology has been continuously improved, and the concept broadened.

With the expansion of developing countries' economies and international trade and the increasing attention paid to the environment and energy, scholars from developing countries began to conduct studies on the relations between trade, the environment and energy consumption. In recent years, especially since the 1990s, international economic circles have been active in calculating and analyzing embodied energy consumption and carbon emission in the worldwide commodity trade using input & output analysis.

From the existing literature, the study report released by OECD (2003) shows that an international, comparative study of some countries on embodied energy in world trade using input & output analysis has been conducted. In addition, there are many country case-studies aimed at a specific country. Machado (2000) made an estimation in a study of embodied energy and carbon in Brazil's foreign trade by using a mixture unit of input & output analysis, concluding that the volume of embodied energy and intensity of carbon in all kinds of commodities increased from 1985 to 1995, of which, that of imports grew quicker than that of exports (because of the fast growth of total imports), and Brazil is a net exporter of energy and carbon. Since then, Machado, Schaeffer and Worrell conducted a study (2001) on the influence of Brazil's foreign trade on its energy consumption and CO_2 emission. They found that the volume of energy and carbon embodied in non-energy products exported by Brazil in 1995 was much greater than that of the imported goods, the energy volume and carbon content in Brazil's per unit export commodities was respectively 40% and 56% more than that of imported commodities, their findings playing an important role in the Brazilian government's adjustment of the relevant policies. Mukhopadhyay (2004) analyzed the commodity and trade structure in the process of Indian trade liberalization, calculating embodied energy and carbon by using input & output analysis to set the index of trade pollution. He found that from 1993 to 1994, the embodied energy and carbon of all the commodities that India exported was less than those it imported, and India is a net importer of energy and carbon. Mukhopadhyay and Chakraborty (2005) made an empirical analysis of the influence of India's emission of CO_2, SO_2 and NO_x in the 1990s and discussed the environmental trade issue. Mongelli (2006) studied the energy consumption problem in Italy's international commodity trade by using input & output analysis, figuring out the volume of embodied energy and CO_2 emission in its commodity trade. Sanchez (2004) calculated CO_2 emission in Spanish economic development and trade on the basis of sectors, comparing the volume of imported pollution and exported pollution by sectors, analyzing the net export volume and estimating the influence of CO_2 emission produced by the energy consumed in the Spanish import & export trade. In addition, Peters' study of Norway (2006), Lenzen's study of Australia (1998), Kondo's study of Japan (1998), are all typical of study literature on the relations between the import & export trade and domestic embodied energy and embodied carbon emission.

Compared to the above mentioned studies, Chinese scholars are late in starting to study the relations between environment and trade, and most of them are qualitative studies such as those by Zhao Jingfeng, Sha Hanying (2006), Chen Xiangdong, Wang Na (2006), Xie Laihui, Chen Ying (2007), etc. In recent years, the study of relations between China's foreign trade and energy consumption, especially quantitative studies using input & output analysis have received public attention. Shen Lisheng (2007) used the input & output model to calculate the influence of China's import & export trade on energy consumption from 2002 to 2005, and concluded that the energy saving of imported products was more than the energy consumption of exported products in China's foreign trade. Since he used the «import substitution» method, this may not be adequate to calculate the embodied energy of imported products according to the domestic energy consumption level, in addition, China is unable to produce some of the imported products, thus it could not correctly reflect the real flow and volume of embodied energy in external trade. Pan Jiahua (2007) used the input & output method to calculate the volume of embodied energy and embodied carbon emission in imported and exported products in China's foreign trade in 2002, and measured and calculated the volume of embodied energy in exports and embodied carbon emission for the years 2002 to 2006. But the sectors were classified roughly in this paper, and the estimation of the imported embodied energy was based on aggregate energy consumption intensity from the country of origin of the import, rather than by sectoral energy consumption coefficients. Liu Feng (2007) calculated the energy consumption coefficient of export goods by using China's input-output table of 122 sectors from 2002, and meanwhile, calculated the energy consumption coefficient of the import goods by using Japan's input-output table of 104 sectors from 2000, finding that during the years 2001 to 2005, the volume of China's embodied energy in exports was about 24% to 33% of the years' total volume of energy consumption. But the embodied energy in the processing trade was not taken into consideration in this study, so that the result may be over estimated. Qi Ye (2008) estimated the volume of embodied energy in China's import & export trade from 1997 to 2006 by using the input & output method. The study used the Japanese energy consumption coefficient most efficient in energy utility, as that of all import goods, and took the result of calculation as the optimistic estimate; it then took the Chinese energy consumption coefficient as that of import products and calculated a conservative estimate. By comparing the optimistic and conservative estimates the range of net exports of embodied energy was given. Using an input-output model, Shen Lisheng (2008) made an empirical study of the influence of China's foreign trade on SO_2 emission, the result showing that the intensity of pollutant emission in China's exports was lower than that of imports, and foreign trade favored a reduction of the country's emission of pollutants but the worsening of the structure of export products led to an adverse balance of SO_2 emission in China's foreign trade.

3. Methodology and Data

At the present stage, the study method used in this kind of study is mainly input & output analysis, but there are some other methods used such as the product life cycle appraisal method for a specific product, etc.

The use of input & output technology makes it possible to explore how changes in final demand lead directly or indirectly to effects on energy and the environment within an economic entity. In the production process of a product, energy consumption is usually divided into two categories: direct consumption and indirect consumption. Direct consumption refers to the energy used directly in the production process of a product; while indirect consumption refers to that consumed by intermediate products and tools in the production process divided according to sector, and these products and tools consume a certain amount of products of related sectors in their own production process. The national economy is a single body composed of many different sectors, these are interdependent with each other, and there is a complex technological and economic relation between them. By using input & output analysis, the total energy consumed by a product (including direct & indirect consumption) in its production process can be calculated.

This study uses input & output analysis, but compared to other scholars at this stage, our study has made a small improvement and expanded the method. First of all, a non-competition Input-Output table must be constructed and an identical equation of input & output should be given as follows:

$$X = (I - A^d)^{-1} Y$$

where X, A and Y respectively represent total output, an intermediate consumption coefficient matrix and final demand. By using this equation, changes in final demand leading to changes in total output can be calculated. For instance, by adding one export unit of a product, changes in the total output of each sector can be calculated .

On this basis, by combining the energy consumption coefficient and the pollutant emission coefficient, the changes in final demand caused by changes in the volume of energy consumption and the volume of emission of pollutant can be calculated leading to the following equation:

$$E = e \cdot \left[(I - A^d)^{-1} Ex \right]$$

where Ex, e and E respectively represent the export demand of each sector, direct energy consumption and each sector's total energy consumption caused by export. When we specifically analyzed the influence of energy, the environment and demand caused by trade between different countries, and then clarified the different trade partners, a further equation was produced, as follows:

$$E_{a,b} = e_a \cdot \left[(I - A_a^d)^{-1} Ex_{a,b} \right]$$

This paper used the above equation to calculate the embodied energy, embodied pollutants, and polluted water in the process of China's foreign trade. Of which, *E* refers to the embodied energy, embodied pollutants and polluted water in the export products from area *a* to area *b*; *e* refers to the embodied energy consumption or pollutant emission coefficient of area *a*'s sub-sector; *A* is the direct consumption coefficient in a non-competitive input-output table; *Ex* refers to the volume of products exported from area *a* to area *b*.

The main differences between this study and other existing studies is not only the use of a non-competitive, input-output table, but also the calculation of embodied energy, polluted water and pollutants, this study uses the input-output table of the import partner country, which could well reflect the difference in energy consumption and production technology between China and its trade partner countries.

The Chinese input-output table (2005) was used in this study; and the other countries' input-output tables were taken from the GTAP Version 7.0.

In general, there are three factors that are very important when calculating embodied energy/emission in international trade. One is the age of the data; the data for China used by all the other studies is pre-2002. As a developing country, China's international trade has increased very fast and China's dependence on international trade has continuously grown. The proportion was 43.9% in 2000 and increased to 63% in 2005. By using the old data to measure embodied energy/emission figures may be underestimated in terms of the current situation. For example, Nadim Ahmad and Andrew Wyckoff (2003) found that the CO_2 embodied in China's exports was about 15% of domestic production in 1997. However, when we used the latest input-output table (2005) we found that the CO_2 embodied in China's exports was about 30% of domestic production. The second factor is the type of input-output table. Some studies use competitive input-output tables, which combine domestic input and non-competitive import input together. To some extent, a study based on this IO table will overestimate the energy/emission embodied in exports. In our study, non-competitive import input was divided from total intermediate input. The last factor is the emission coefficient. Some studies (such as Shen Lisheng 2007), Shen Lisheng (2008), Qi Ye (2008)) use China's emission coefficient to calculate the energy/emission embodied in China's imports. Actually, the direct emission coefficient of China is much higher than that of developed countries. Nadim Ahmad and Andrew Wyckoff (2003) showed that the average emission factor per dollar of export for China's is 2.9 kg while the figures for USA and Germany were only 0.5 and 0.4. Consequently, these studies may overestimate the energy/emission embodied in China's imports. Some studies, such as Pan Jiahua's (2007) adjust China's emission coefficient to get the emission coefficient for China's trade partners, based on the difference of emission intensity per GDP. Even so, they neglected the difference of trade composition. In our study, we used the emission coefficients by sector for China's major trade partners based on GTAP energy and emission data.

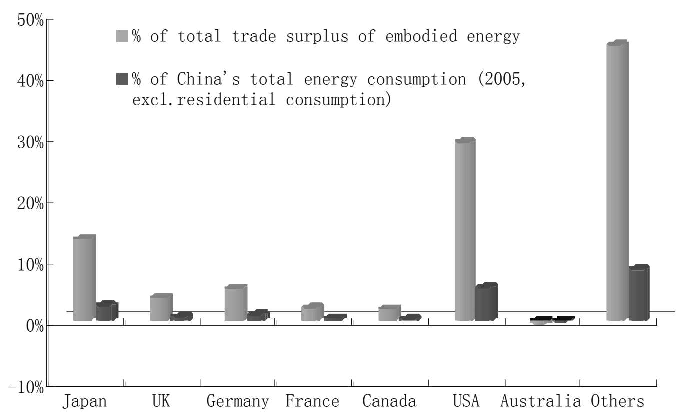
4. *Calculating the result*

By using the above equations, this study measured and calculated embodied energy, water resource and pollutant emission (SO_2, CO_2 and COD).

4.1 Embodied energy in foreign trade

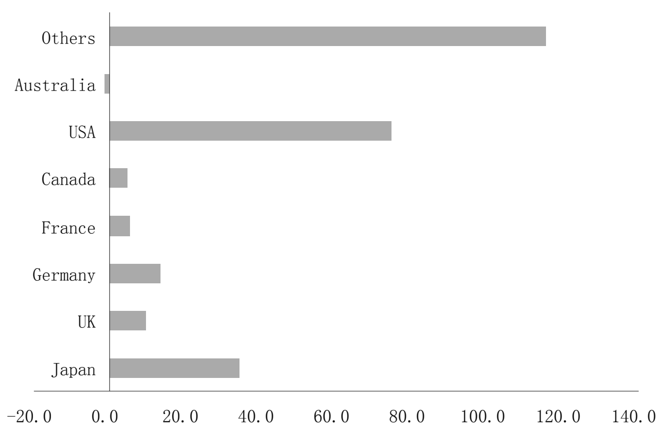
China's commodity exports reached $ 761.95 billion in 2005, of which, the embodied energy consumption was the equivalent of 412 million tons of oil; and China's commodity imports reached $ 659.95 billion in the same year, of which, the embodied energy consumption was 156 million tons of oil equivalent. Thus, it could be seen that China had a trade surplus of $ 100 billion, but exported 256 million tons of oil equivalent. The embodied energy surplus in the import & export trade was equivalent to 18% of the total energy consumption volume (not including households' consumption). From the point of view of the relative relations of imports & exports, the volume of exports in 2005 was only 15% higher than that of imports. From the point of view of embodied energy, the volume of embodied energy for exports was 2.6 times higher than that of imports; from the point of view of the intensity of embodied energy in external trade, embodied energy in exports per $ 10,000 was 5.5 tons of oil equivalent, while the embodied energy in imports per $ 10,000 was only 2.4 tons of oil equivalent, i.e. the intensity of embodied energy in exports was equivalent to 2.3 times that of imports.

Figure 1. Embodied energy in China's foreign trade.



Below is an analysis according to trade partner country of the embodied energy in China's foreign trade. Fig. 1 and Fig. 2 show the surplus and deficit of embodied energy between China and its key trade partner countries. The surplus refers to China's net export of embodied energy, while the deficit refers to China's net import of embodied energy. It can be seen from Fig. 1, that the smallest gap in embodied energy was between China and Australia. China has a great surplus compared to its six other key trade partners, especially US and Japan, of which, the surplus over US and Japan accounts for 30% and 13% respectively of total embodied energy. From a more detailed point of view, the volume of embodied energy in China's export commodities to the US reached 82.6 million tons of oil equivalent, while the volume of embodied energy in US import commodities was only 8.1 million tons of oil equivalent; exports were roughly equal to 10 times imports, meanwhile, the surplus volume of embodied energy between Sino—US trade was about 5% of China's total energy consumption.

Figure 2. Surplus/Deficit of embodied energy for China's international trade (Mtoe, 2005).



For a better understanding of the volume of embodied energy in Sino-US trade, we will compare the difference between China's sectoral energy intensity and the trade result. Figure 3 shows a comparison of energy consumption intensity in the Sino—US sub-sectors. The data in Fig. 3 shows that the energy consumption of China's total output for $ 100 was 0.021 oil equivalent in 2005, while in the US it was only 0.009 oil equivalent, the former is 2.3 times the latter. From a more specific point of view, generally speaking apart from the oil processing industry, the energy consumption intensity of other industries in China is much higher than in the US, compared to which, China has a higher number of other manufacturing industries, mining industries and building materials.

Figure 3. Sectoral energy intensity for China and US (TOE/$100).

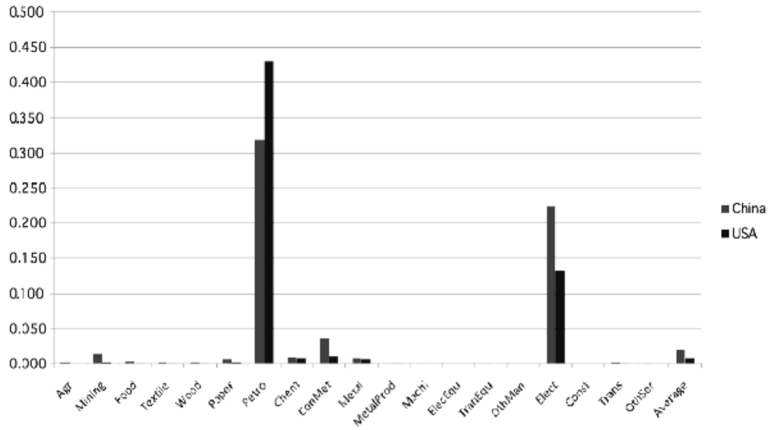
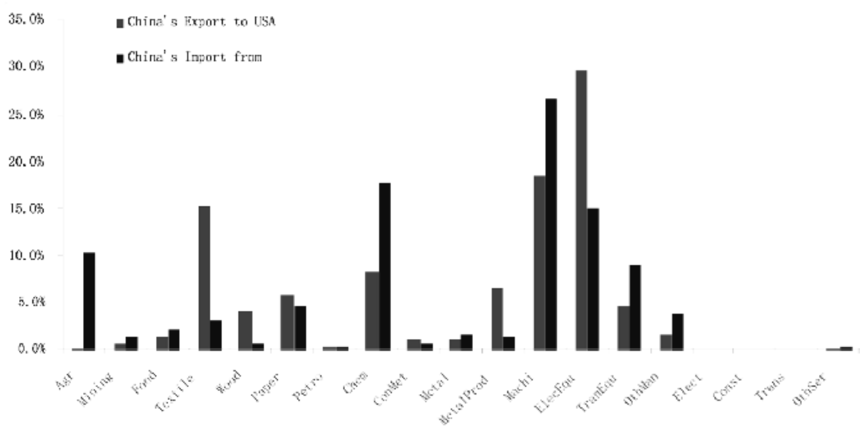


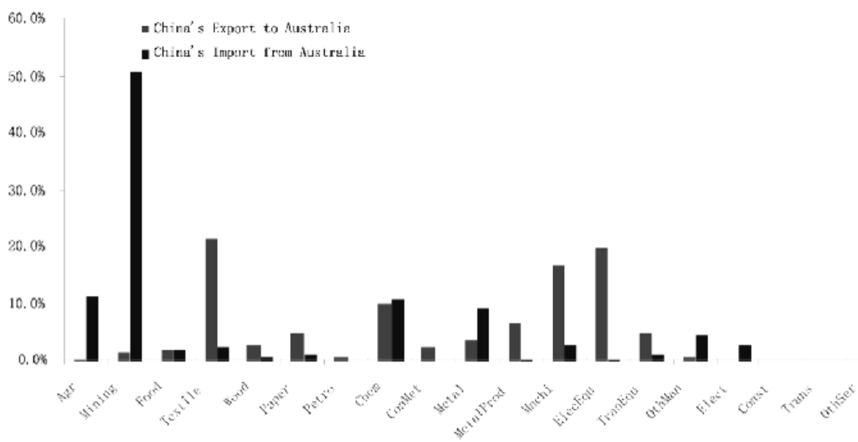
Figure 4 shows the sectoral composition of Sino—US trade, from which it can be seen that China's exports to the US are mainly electronic equipment, clothing, paper products, metal products and building materials; while China's imports from the US are mainly electronic equipment, machinery equipment, chemical products, farm products and transportation equipment. Among which, a number of key. high-energy intensive industries in Sino—US trade for which China is in a surplus state, such as building materials, metal products and mining products.

Figure 4. The sectoral composition of trade between China and USA.



As regards trade with Australia, the volume of embodied energy in export commodities to Australia was 6.1 million tons of oil equivalent in 2005 while the volume of embodied energy in import commodities from Australia was 7.3 million tons of oil equivalent, giving a deficit of 1.2 million tons of oil equivalent. As regards the structure of trade between China and Australia, Fig. 5 shows the sectoral composition of China—Australia trade. The data in the table shows China's exports to Australia are mainly clothing and electronic equipment, of which, clothing occupies 22% of total exports; while Australia's exports to China are mainly mining products (mainly ore) and farm products, of which, mining products account for 51% of total exports. The high energy consumption coefficient of the mining industry and the high ratio of imported ore in Chinese—Australian trade means that China is in a deficit state as regards the volume of embodied energy in Chinese—Australian trade.

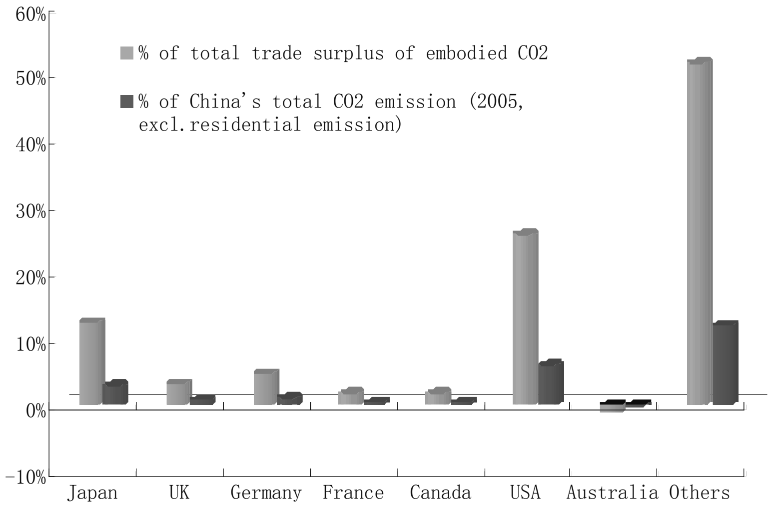
Figure 5. Sectoral composition of trade between China and Australia.



4.2 Embodied CO_2 in foreign trade

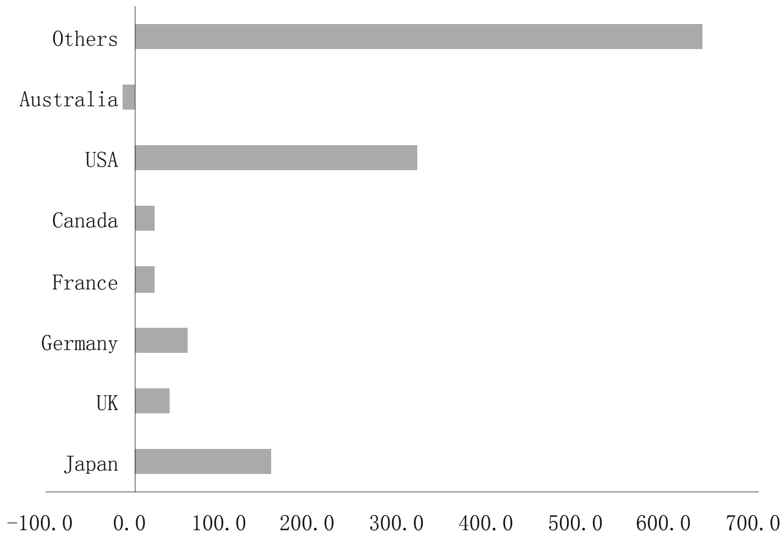
From the point of total volume, the volume of emission of embodied CO_2 in China's exports in 2005 reached 1.6 billion tons; the number in import commodities reached 368 million tons, thus, the surplus of embodied CO_2 in China's foreign trade in 2005 was 1.233 billion tons, which was equivalent to net imports by China abroad of 1.233 billion tons of CO_2 in 2005. The surplus volume of embodied CO_2 in foreign trade was equivalent to 23% of the country's yearly CO_2 emission volume. From the point of view of the relative foreign trade relations, the value of export was only 15% higher than the import value, while from the point of view of the volume of embodied CO_2, the volume of embodied CO_2 in exports was equivalent to 4.4 times that of imports; as regards CO_2 emission intensity, the volume of embodied CO_2 in exports for $10,000 was 21.3 tons, while for imports of $10,000 it was only 5.7 tons, i.e. the embodied CO_2 emission intensity of exports was equivalent to 3.7 times that of imports.

Figure 6. Embodied CO_2 in China's international trade.



Now we will analyse the volume of embodied CO_2 emission in China' s foreign trade from the point of view of its key trade partner countries. Fig. 6 shows the surplus and deficit volumes of embodied CO_2 in China's foreign trade with its key trade partner countries. The surplus refers to China's net import of CO_2 from other countries, while the deficit refers to China's net export of CO_2 to other countries. It can be seen from Fig. 6 how apart from a minor deficit of the volume of embodied CO_2 with Australia, China has a great surplus over its six other key trade partner countries and other trade partners, especially the US and Japan. Of which, the surplus volume of embodied CO_2 in its trade with the US and Japan accounts for 26% and 12% respectively of the total. From a more specific point of view, the embodied volume of CO_2 in China's export commodities to the US reached 336 million tons in 2005, while that of imports from America was only 0.19 million tons, the volume of exports was 18 times more than imports while the surplus volume of embodied CO_2 in Sino—US trade was the equivalent of 6% of China's total volume of CO_2 emission in 2005.

Figure 7. Surplus/Deficit of embodied CO_2 in China's international Trade (Million Metric Ton, 2005).



The difference in the intensity of CO_2 emission between Sino—US sectors can also be seen. In 2005, the volume of CO_2 emission of total output in China for $100 was 0.08 ton, while in America it was only 0.022 ton, the former is 3.7 times higher than the latter. From the point of view of each sector, China's emission intensity is usually higher than that of the US.

4.3 Embodied SO_2 in foreign trade

In 2005, the volume of embodied SO_2 emission in China's exports was 5.54 million tons, while for import commodities this figure was 250,000 tons, thus, the surplus of SO_2 in China's foreign trade in 2005 was 5.29 million tons, which was equivalent to China's net import of 5.29 million tons of SO_2 in 2005. The surplus volume of embodied SO_2 in foreign trade was equivalent to 38% of the country's yearly total. As regards the relative relations of imports & exports, exports were only 15% higher than imports in 2005 while as regards the volume of embodied SO_2 , exports were 22 times imports; as regards the emission intensity of SO_2, the volume of embodied SO_2 per million dollars of exports was 7.4 tons, while for the same number of imports it was only 0.4 ton, i.e. export embodied SO_2 emission intensity was equivalent to 19 times that of imports.

Figure 8. Embodied SO_2 in China's international Trade (2005).

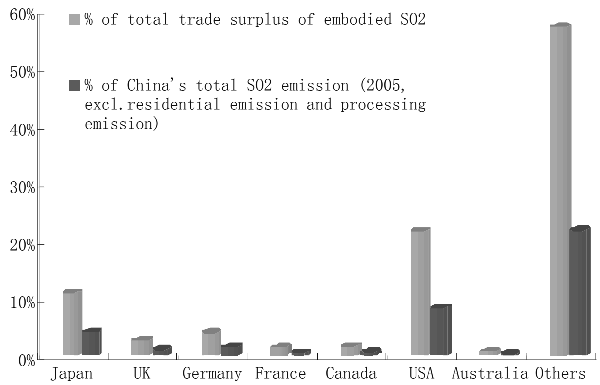
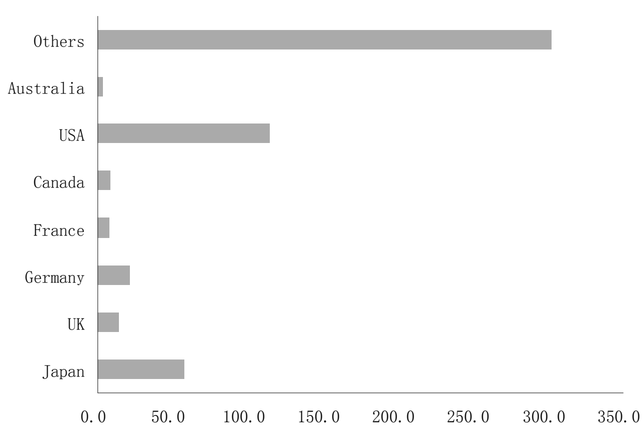


Fig. 8 and Fig. 9 show the surplus and deficit of embodied SO_2 in China's foreign trade with its key partner countries. The surplus refers to China's net import of SO_2 from other countries; the deficit refers to China's net export of SO_2 to other countries. As regards energy resources, Fig. 8 shows China's surplus compared to the 7 other key trade partner countries, especially the US and Japan, of which, China's surplus volume of embodied SO_2 to the US and Japan was 22% and 11% respectively of the total. Taking the US as an example, the volume of embodied SO_2 in China's export commodities to America reached 1.18 million tons, while for China's imports from America this figure was only 38,000 tons, the volume exported being 30 times that imported, the surplus volume of embodied SO_2 in Sino—US trade was the equivalent of 38% of China's total volume of SO_2 emission in 2005.

Figure 9. Surplus & Deficit of embodied SO_2 in China's international Trade (10000 ton, 2005).

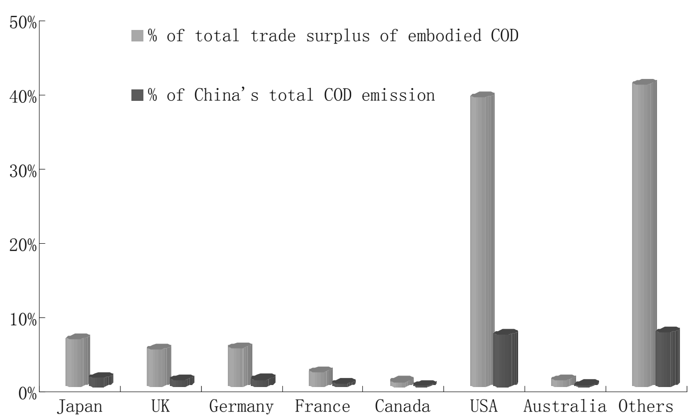


The difference of SO_2 emission intensity between Sino—US sectors can be observed. In 2005, the volume of SO_2 emission of total output in China for $100 was 0.027 ton, while in the US this figure was only 0.005 ton, the former being 5 times higher than the latter. Looking at a specific sector, China's emission intensity is usually much higher than that of the US.

4.4 Embodied COD in foreign trade

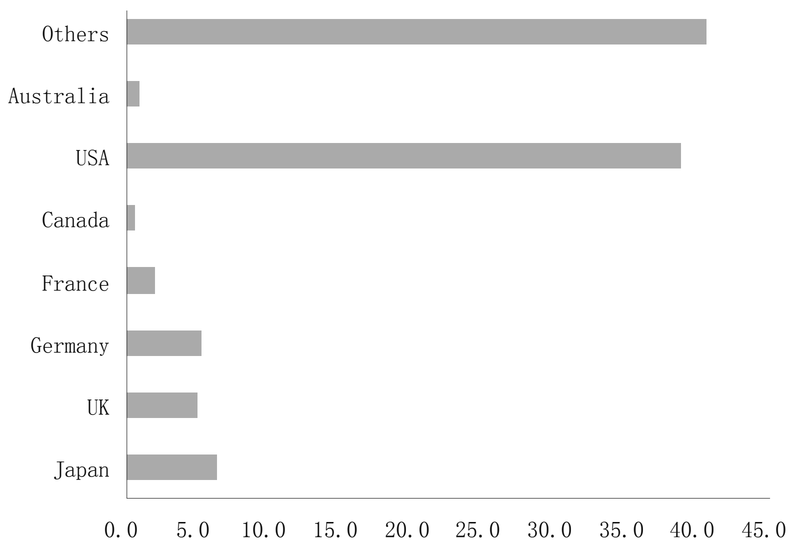
From the point of total volume, embodied COD (Chemical Oxygen Demand) emission in China's exports in 2005 reached 2.03 million tons while the same figure for import commodities reached 1.04 million tons, the surplus of embodied COD in China's foreign trade in 2005 was therefore 0.99 million tons, the equivalent of China's net import of 0.99 million tons of COD in 2005; the surplus volume of embodied COD in foreign trade was equivalent to 1.85 million tons of the year's total. As regards relative import & export relations, the value of exports was only 15% higher than imports while from the point of view of embodied COD, export embodied COD was equivalent to 2 times that of imports; from the point of view of COD emission intensity, export embodied COD per million dollars output was 2.7 tons, while for imports it was only 1.6 tons, i.e. export embodied COD emission intensity was equivalent to 1.7 times that of imports.

Figure 10. Embodied COD in China's international Trade (2005).



Now let us analyze the volume of embodied COD emission in China's foreign trade from the point of view of its key trade partner countries. Fig. 10 and Fig. 11 show the situation of surplus and deficit of embodied COD in China's foreign trade with its key trade partner countries. The surplus refers to China's net import of COD from other countries; the deficit refers to China's net export of COD to other countries. Fig. 10 shows China's surplus compared to its 7 other key trade partner countries, especially the US, with its surplus over US and Japan accounting for 40% of the total embodied COD surplus. Taking America as an example the embodied COD in China's export commodities to the US reached about half a million tons, while the same figure for imports from the US was only 110,000 tons, the volume exported was equivalent to 4.6 times that imported with the surplus volume of embodied COD in Sino-US trade equivalent to 7% of China's total COD emission volume in 2005.

Figure 11. Surplus/Deficit of Embodied COD in China's international trade (10000ton, 2005).



5. Conclusions and Implications

Based on the analysis above, China has a large surplus in its commodity trade, but due to its trade structure featuring exports of high energy intensive products and also China's low efficiency in the utilization of energy, it can be concluded first of all that China is a net exporter of embodied energy and net importer of embodied CO_2, SO_2, and COD emission.

Although China has enjoyed rapid economic growth in its process of industrialization, it needs to thoroughly consider the balance of the industrial structure in this process. There has been a very high growth rate of energy intensive products such as iron and steel and non-ferrous metals in recent years due to the rapid rise in urbanization and demand for downstream products such as automobiles and high demand for infrastructures. But an overall perception of the choice of growth rate of GDP in the long term and appropriate share of various sub-sectors is needed; for example, the railway may consume less iron, steel and energy than the motorway. And innovation should be encouraged to design new materials to substitute iron and steel. The process of urbanization can also be implemented with better city planning. This is a very complex task and requires much national effort.

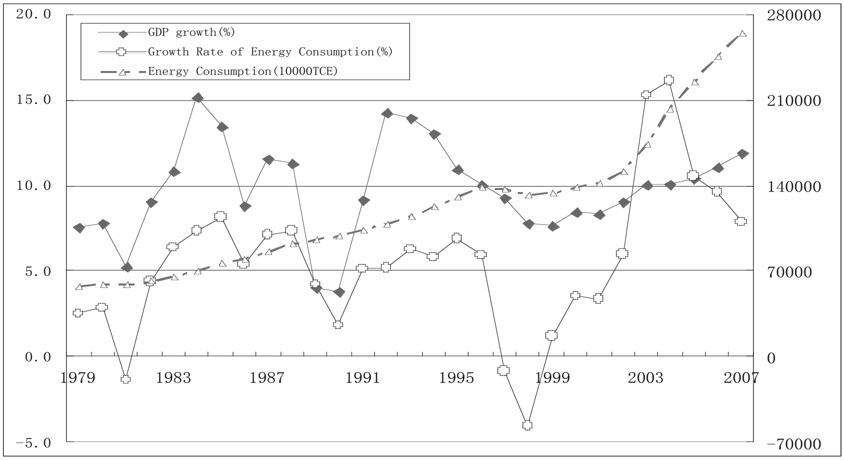
APPENDIX
ENERGY UTILIZATION IN CHINA

Since its reform and opening up to the outside world, China's national economy has maintained a very high growth rate and its social productivity level has greatly improved. In 2007, its total GDP reached 25,730.6 billion Yuan, ranking Third in the world. From 1979 to 2007, China's GDP increased by 13.5 times with an average annual growth rate of 9.8%, 6 percentage points higher than that of the world average, 7% higher than that of the developed countries, 5% higher than developing countries and top of the list of the world growth rates. Since 2000 Chinese economic growth has accelerated year by year. During the 10th Five Year Plan period (2001-2005) the average annual growth rate was 9.5%, which was 0.9 percentage points higher than during the 9th Five Year Plan. The GDP growth rate reached 11.1% in 2006 and 13% in 2007 respectively. In recent years, economic growth has revealed a trend of «high growth, high investment, high consumption, high pollution and low efficiency». From the point of view of energy saving and environmental protection, the cost of such recent fast growth is very high.

1. High rise in energy consumption

Between 1978 and 2005 the annual average growth rate of energy consumption was 5.16%; during the period of the 10th Five-Year Plan, the speed of growth of energy consumption had already surpassed that of the economy, which reached 9.9% of the annual average growth rate, specifically, in 2002 and 2003 the growth rate of energy consumption reached 15.3% and 16.1% respectively, far beyond the growth rate of the economy (around 10%).

Figure A- 1. GDP Growth Rate & Energy Consumption.



2. Continuous rising proportion of energy consumption compared to world energy consumption and dependency on foreign trade

Figure A-2 shows the proportion of China's volume of energy consumption to that of the world. It can be seen from Figure A 2 that the proportion of China's energy consumption to that of world consumption has rapidly increased, from 12.6% in 2006 to 15.6%, at about 1 percentage point annually.

Figure A-2. The proportion of China's energy consumption compared to that of the world.

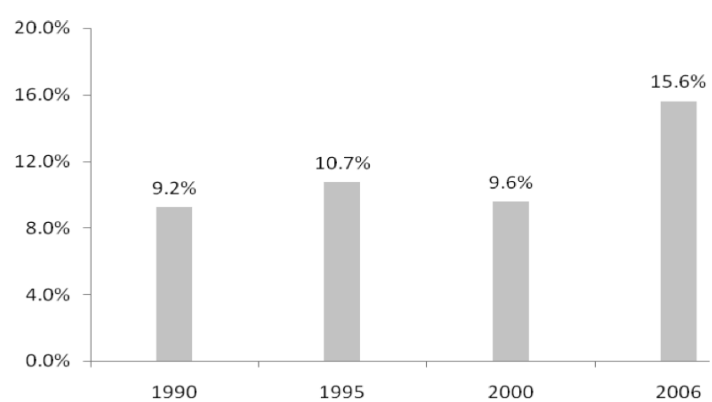
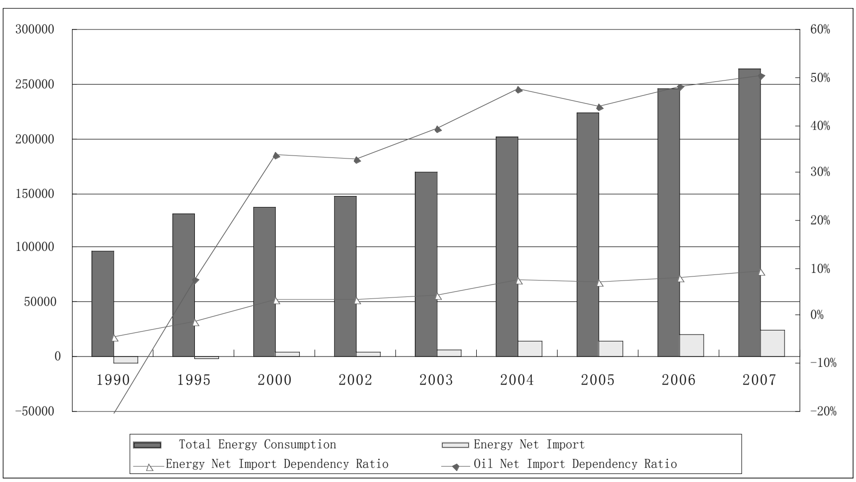


Figure A-3 shows the situation of China's energy consumption volume, net import volume, import dependency and oil import dependency. Before the mid-1990s, the domestic energy market remained in a state of supply exceeding demand, i.e. the energy produced exceeded total consumption, and guaranteed a certain amount of export volume each year. Since then domestic energy production has fallen short of consumption, and there was a rapid rise in imported energy with energy import dependency continuously increasing. Total energy net import dependency increased from -5% in 1990 to 13% in 2007; and oil net import dependency grew rapidly from -20% in 1990 to 34% in 2000, in 2007 oil import dependency further increased to 50%, the oil import volumes began to reach domestic oil production volumes. With the rise in energy import dependency, the overseas energy market imposes an increasing influence on the domestic energy market and the overall national economy.

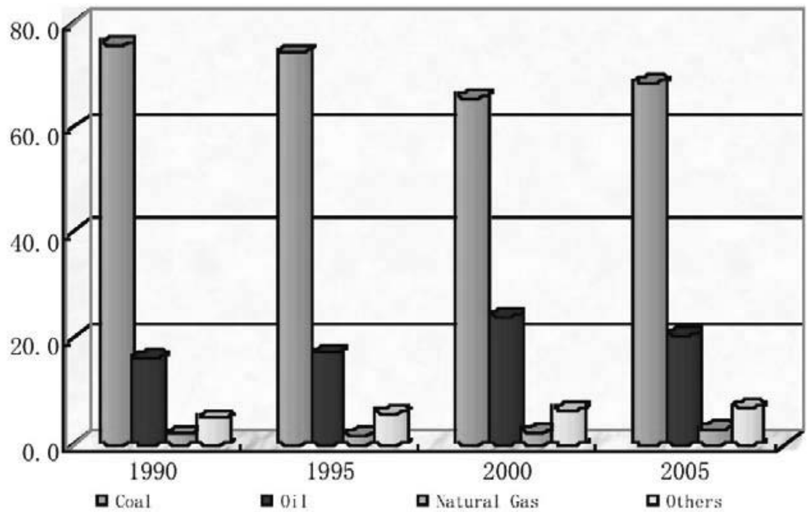
Figure A-3. China's total energy, volume of oil consumption & net import & import dependency.



3. Oil accounts for a higher proportion of total energy while the share of coal is declining

Figure A-4 shows the structural changes of energy consumption since the 1990s. As a whole, on the one hand, the proportion of oil consumption in total energy consumption has increased continuously, from 16.6% in 1990 to 24.6% in 2000, on the other hand, the share of coal in energy consumption decreased quickly, nearly 10% from 1990 to 2000. Since the year 2000, the rapid rise of international oil prices and fast rise of the domestic energy demand led to a rapid increase in coal production and consumption, and accounted for a higher proportion of total energy consumption, while the share of oil consumption fell slightly. Generally speaking, with social development, the proportion of relatively clean energy consumed should increase and that of heavy polluted energy should decrease.

Figure A-4. Structural changes in energy consumption since the 1990s.

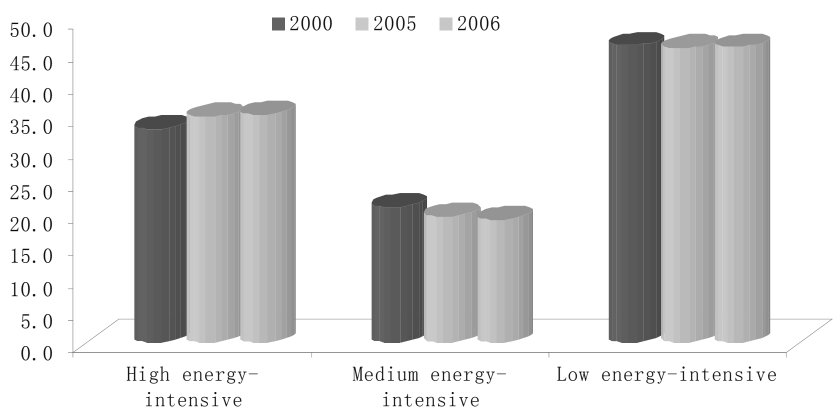


4. The proportion of high energy intensive sectors has increased continuously in recent years

In recent years there has been a rapid growth of investment in industrial sectors causing a rapid expansion driven by ferrous metallurgy and press processing, chemical materials and product manufacturing, metalloid mineral products, transportation equipment manufacturing, the textile industry, the pharmaceutical industry, non-ferrous metallurgy and press processing, i. e. the rapid rise in investment in iron and steel, electrolyte aluminum, cement, cars and textiles, etc. Statistics show that in 2003 alone, among the projects valued at over RMB 5 million Yuan, investments in iron and steel increased by 96,6%; in electrolyte aluminum by 92.9%; in cars by 87.2%; in textiles by 80,4%; in coal by 52.3%. In 2004, with the implementation of respective macro regulation policies, though there were some declines in investment in these sectors, it was still higher than in other sectors. Apart from manufacturing, the investment in the power production sector in secondary industry increased very fast, driven by the high demand for power.

Figure A-5 shows the share of total industrial output produced per sector with different energy consumption levels in 2000, 2005 and 2006. Figure A 5 shows that during the Tenth Five-Year Plan, the proportion of high energy consumption sectors increased greatly with a 1.9% rise, among which, the metallurgical sector topped the list of energy consumption, rising from 8.06% in 2000 to 11.69% of total industrial output in 2005, a rise of 36.63%; coal mining ranked second, the proportion of its total output increased by 0.78 percentage point; the proportion of medium and low energy consumption sectors decreased slightly with the proportion of medium energy consumption sectors dropping greatly, nearly 1.5 percentage points.

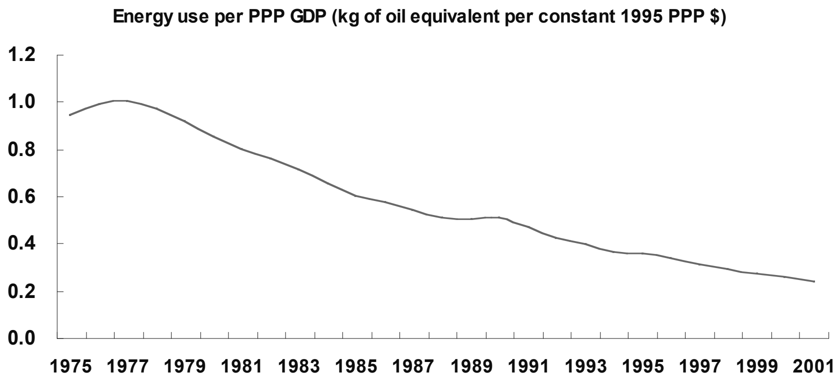
Figure A-5. Share changes of total output by industrial sectors with different energy consumption (2000--2006).



5. Though energy utilization efficiency has improved continuously, there is still a great gap between China and developed countries

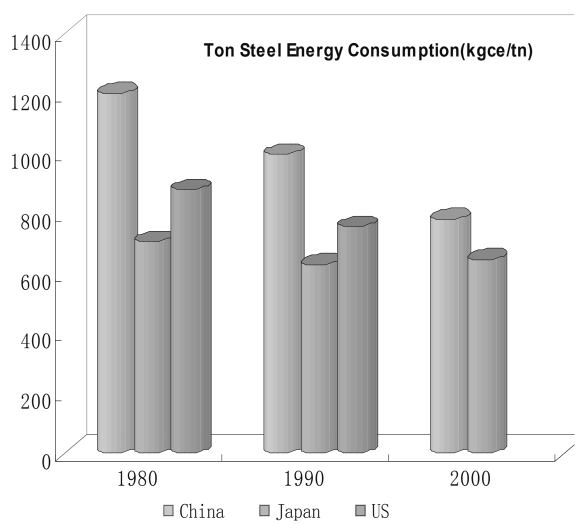
Fast economic growth in China has brought the fast growth of energy consumption and with the continuous increase in energy consumption, energy utility efficiency has continuously improved. Figure A 6 shows energy consumption volume per unit GDP calculated according to PPP released by the world Bank. The declining speed of China's energy consumption per unit GDP was very quick. It dropped from 1kg/1$ in the 1970s to 0.24kg/1$ in 2001, an annual average decrease of 5%.

Figure A-6. Changes of energy consumption volume per unit GDP in China.



To facilitate an international comparison, this paper selected the steel and truck sectors as two items for study. From the data in Figure A- 6, China's energy consumption level is still obviously higher than the developed countries. Take steel making for example: in the year 2000, China's tonnage of steel energy consumption was 781 tons SCE (Standard Coal Equivalent) while that of Japan was only 646 ton SCE, China was 21% higher than Japan; for truck transportation, in the year 1995, China's gasoline truck oil consumption volume per 100 km was 7.06 litres, diesel truck oil consumption volume was 4.8 litres while that of America was only 3.5 litres.

Figure A-7 An International Comparison of Tonnage Steel Energy Consumption.



Though a great improvement has been made in terms of efficiency of energy consumption, it is still much lower in China than in the developed countries in this field.

References

Chen Xiangdong, Wang Na (2006). A Research on the Problem of Energy Consumption in Exporting Countries under International Trade Framework. *Journal of International Trade*, 3(117).

Dan Shi (2006). Regional Differences in China's Energy Efficiency and Conservation Potentials. *China industrial economy*, 10: 49-52.

Hae-Chun Thee. Hyun-Sik Chung (2006). Change in CO2 Emission and Its Transmissions Between Korea and Japan using International Input-output Analysis. *Ecological Economics*, 58: 788-800.

Jiahua Pan *et. Al* (2007). *International policy of Climate change: China's study.* Beijing, China's Environmental press.

Kahrl Fredrich, Roland-Holst David (2008). Energy and exports in China. *China Economic Review*, Elsevier, 19(4): 649-658.

Kondo Y., Moriguchi Y., Shimizu H. (1998). CO2 emissions in Japan: Influences of Import and Export, *Applied Energy*, 59.

Lenzen M. (1998). Primary Energy and Greenhouse Gases Embodied in Australian Final Consumption: an Input-output Analysis. *Energy Policy*, 26(6).

Lenzen M. **(**1998**)** Energy and Greenhouse Gas Emissions Embodied in Trade. Paper Presented at the 14th International Conference on Input-output Techniques held at UQAM, Montreal, Canada, October.

Liu Feng (2007). *Research on Energy Consumption of Trade in China*. Master's thesis, Beijing, Tsinghua University,.

Machado G. (2000). CO2 Emissions and Foreign Trade. An IO approach applied to the Brazilian Case. International Conference on Input-Output Techniques, Macerata, Italy.

Machado G., Schaeffer R., Worrell E. (2001). Energy and Carbon Embodied in the International Trade of Brazil: an Input-Output Approach. *Ecological Economics*, 39(3).

Mongelli I., Tassielli G., Notarnicola B. (2006). Global Warming Agreements, International Trade and Energy/Carbon Embodiments: an Input-Output Approach to the Italian Case. *Energy Policy*, 34(1).

Mukhopadhyay Kakali (2004). Impact of liberalized trade on energy use and environment in India. *Journal of Environment and ecology Management*, 1(1).

Mukhopadhyay K., Chakraborty D. (2005). Environmental impacts of trade in India. *International Trade Journal*, 19(2).

Nadim Ahmad. Andrew Wyckoff (2003). Carbon Dioxide Emissions

Embodied in International Trade of Goods. *OECD STI Working Papers*, 15.
Peters G. P., Hertwich E. G. (2006). Pollution Embodied in Trade: the Norwegian Case. *Energy Policy*, 34(1).
Qi Ye *et.al.* (2008). Accounting Embodied Energy in Import and Export in China. *China Population Resource and Environment*, 18(3): 69-71.
Sanchez C. J., Duarte R. (2004). CO2 Emissions Embodied in International Trade: Evidence for Spain. *Energy Policy*, 32(18).
Shen Lisheng (2007). China's international trade structure are not conducive to energy saving, *Management World,* (10): 43-46
Shen Lisheng (2008). The effect of international trade on emission of SO2. *Management World*, 7: 21-23
Xie Laihui, Chen Yin (2007). A Review and Analysis on Carbon Leakage. *Advances in Climate Change Research*, 7(214).
Zhao Jingfeng, Sha Hanying (2006). New Trend of Relation between Trade and Environment in Developed Countries. *Environment and Sustainable Development*, 3(38).

THE LONG TERM PROSPECTS OF RUSSIA'S ENERGY POLICY (2009-2030)

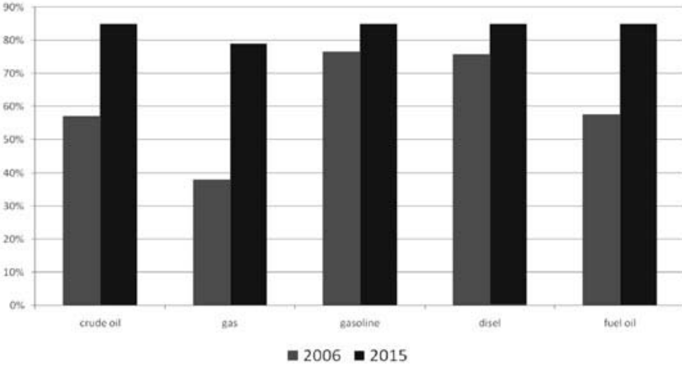
Alexander Shirov, Alexey Yantovskiy
Institute for Economic Forecasting, Russian Academy of Sciences

1. The current situation in the Russian energy sector

At the moment, the Russian economy has the seventh biggest volume of GDP world-wide. Russia has considerable, explored reserves of oil and natural gas as well as a well-developed industry so that the development of Russia's economy and energy sector may be an important factor in the development of the world economy. For example: in the formation of oil and gas prices or in the Kyoto process.

Currently, the domestic prices of energy resources tend to approach world prices and the difference is expected to practically disappear (Fig. 1). If net-back revenues are taken into account they could be considered equal. This means that Russian companies working in the energy field cannot expect to increase their profits from domestic markets and need to plan future development very carefully. Given the significant role of the energy sector in the Russian economy, this will undoubtedly affect the entire national economy, leading to a growing need for long-term forecasts.

Figure 1. Domestic and export price relations.



Maurizio Grassini and Rossella Bardazzi (edited by), *Energy Policy and International Competitiveness*,
ISBN 978-88-6453-040-6 (print) ISBN 978-88-6453-043-7 (online)

The government has made its first attempt to develop a long-term economic strategy for the period up to 2020 and the business community too is showing an increasing interest in long-term forecasts. This is an indication of the country's transition to a new kind of economic policy based on setting a priority on long-term development and planning the business activities of key economic agents on a regular basis. These programs are one of the positive signs of the interest taken by economic agents, according to their character, in long-term sustainable economic growth. These forecasts include estimation of the key constraints to growth, measures for overcoming them, the creation of conditions for planned growth in terms of the state, corporation, enterprise. At the same time, these long-term programs and the decisions based on such, need to be closely controlled given that the cost of possible prioritization errors, increases immensely for 20 -30 years ahead.

Further economic growth requires enormous financial injections, investment decisions being hindered by the uncertainty of economic prospects. Long-term strategies and forecasts are a relatively new kind of activity for contemporary government and business structures, and even economic experts have little experience in such matters. The Soviet-period experience is not always appropriate, nor can the methods used elsewhere be directly replicated with any positive results. One of the main problems faced by designers of *comprehensive* national economic forecasts is the transition from calculating national indicators at a macroeconomic level to calculating indicators at the level of individual sectors and technologies. Numerous directions and feedback to the economy need to be analysed. This task cannot be performed on the basis of expert's estimates alone but requires the use of modern, comprehensive modelling instruments enabling the complex interactions of today's national economy to be traced.

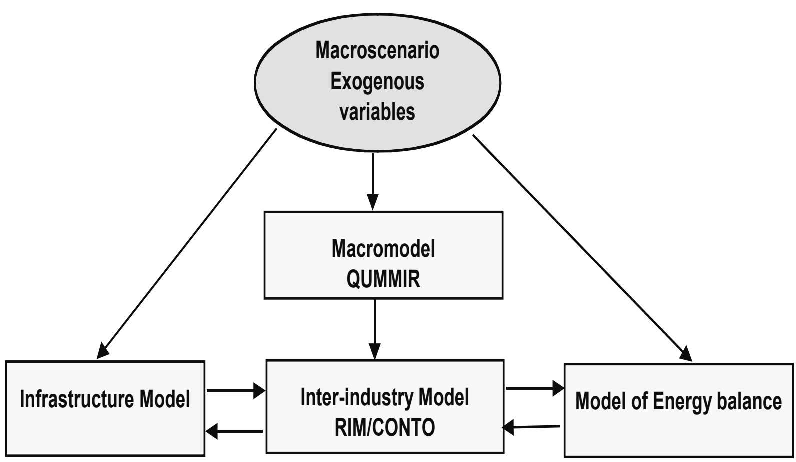
2. The model environment for long-term energy forecasts

One way of improving socio-economic planning and forecasting, used in part by government structures, is to include sectoral growth strategies in overall, national economic concepts and forecasts. However, in order to be used as an integral part of the long-term strategy, sectoral programs have to meet a number of stringent requirements. First of all, programs differing in their aims and tasks must be co-ordinated at the level of both intersectoral and macroeconomic indicators. In other words, indicators characterizing sectoral strategies must be calculated starting from uniform macroeconomic scenarios and, concurrently with this, basic indicators of economic growth must be determined. This can be achieved in two ways: either macroeconomic and sectoral strategies should be created by a single group of analysts (which is unlikely), or the work on these documents should be clear-cut and regulated so as to enable co-ordination of the basic indicators of long-term strategies. Another necessary condition, in our view, is the *concurrent* development of a long-term strategy at both macroeconomic and sectoral levels. The Russian government's recent attempts at such organization have been observed. In 2007, the Concept of Long-term Socio-economic Development of the Russian Federation, the Development Strategy of Rail Transport in the Russian Federation up to 2030, the General Plan for the Allocation of Electric Power Generation Facilities for the Period up to 2020, the Development Strategy of the Chemical and Petrochemical Industry for the Period up to 2015, the Development Strategy of Transport Vehicle Building of the Russian Federation from 2007-2010 and for the period up to 2015, etc., were presented.

The use of the official government forecasts as the basis for calculations makes it possible to co-ordinate the possible strategy for the country with the changing situation in actual national economic groups. This is even more important as at the moment this forecast is probably the fullest comprehensive study of the future of the Russian economy.

The complicated nature of the inter-industrial interactions analyzed requires a system of calculating economic indicators at the national, economic and industry levels. To co-ordinate these, many of the existing instruments will need to be used. The group of models used in the paper includes: the macroeconomic model QUMMIR, the inter-industry macroeconomic model CONTO, an infrastructure model, an energy balance model and a number of industry sub-models (Fig. 2).

Figure 2. Diagram of the group of models.

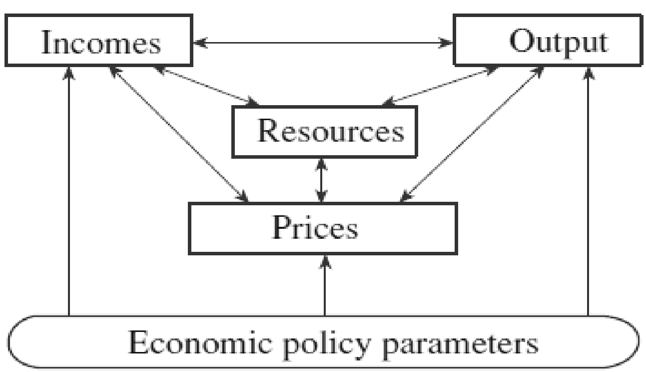


The basic macroeconomic parameters and elasticities were defined in the Quarterly Macroeconomic Model of Interactions for Russia (QUMMIR) (Uzyakov 2006). The QUMMIR model (Figure 3), reflecting the interaction between production, incomes, and prices in the economy, is essentially a closed system in which endogenous variables depend on each other and on exogenous variables, which are, as a rule, parameters of the economic policy or of external (relative to the Russian economy) conditions. The general scheme of the interactions between variables in this model is as follows:

At the modern stage of this model, a production forecast is made according to «final demand» and does not take into account labour and capital constraints. In our opinion, this drawback is not significant given the short-term nature of this forecast. The baseline concept determines the structure and content of the forecast and analytical material:

- the probable course of events is evaluated by existing trends and the economic policy;
- forecast results are explained on the basis of the inter-relations used in this model and the quantitative values of equation parameters;
- the objective evaluation of the quality of forecasts and the model is ensured (in particular, starting with the second issue of the quarterly forecast, we intend to publish a comparative table of forecasts and the actual values of the variables).

Figure 3. Diagram of the interactions of the QUMMIR model.



The QUMMIR model calculates final demand to obtain forecasts of the values of GDP-use and income-formation accounts. The production account is not developed at this stage. In this regard, resources are represented only by the exogenous variables of oil and gas exports and the number of employees in the economy, needed to calculate export and the characteristics of labour productivity.

The interaction between the respective price and income variables determines the physical dynamics of all final-demand elements except exports. Exports depend mainly on exogenously specified oil and gas exports, the world oil price and the dynamics of production in EU countries.

In the CONTO inter-sectoral model a 45-sector classification of the sectors of industry and the national economy is used. The International Energy Agency (IEA) classification was chosen as the basis for calculation models of the energy balance. The infrastructure model includes the sub-model for cargo traffic based on inter-sectoral balance instruments and appropriate transport matrices and the system of equations for forecasting passenger traffic (Shirov, Yantovskiy 2008).

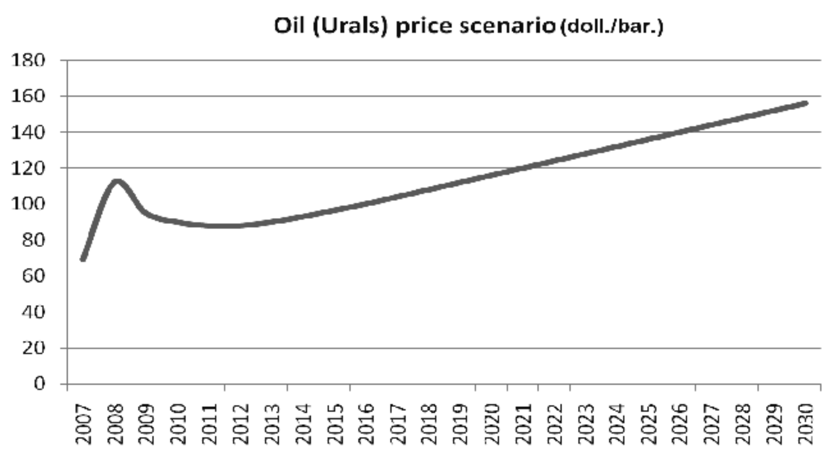
3. *The scenario for the economy and the development of the energy sector*

The main exogenous variables in our calculations were: capital intensity, the structure of power generation, the parameters of labour activity and wages, demographics, tax rates, exchange rates and oil prices.

We did not consider world demand as a main factor for our model. In the model, the export of energy sources was estimated as the difference between output and domestic consumption. Thus we assumed that the world demand for energy resources would be high enough in the long term. So any volume of Russian energy exports would be demanded by foreign consumers.

We also assumed that in the long term oil prices would rise even though they are falling in the short-term. This assumption was based on IEA and international oil company forecasts (Figure 4).

Figure 4. Oil prices scenario.



The innovation factor was based on the relative scenario presented in the Concept of Long-Term Socio-economic Development of the Russian Federation presented by the Ministry of Economic Development and Trade in 2008[1]. This option is based on the assumption of a sustainable high rate of economic growth being achieved over the whole forecast period. In this option, investments in fixed capital are appreciably higher. Investment is the main tool for addressing long term development challenges; it is only through investment that we can overcome structural, technological and resource constraints.

International comparisons show that, all other conditions being equal, the main factor in ensuring higher rates of economic growth is an increased rate of accumulation. For example, the growth rate gap between China and the United States in recent years – 10% in China versus 4% in the United States –can be almost fully explained by the differences in the rate of accumulation, 40% and 17% respectively. Of course, the difference in the rates of economic growth is not only due to the rate of accumulation. Obviously, the United States cannot, in theory, have 10-percent positive growth given the saturation of the main needs of the economy and the population. Arguably, however, if China were to decrease its rate of accumulation to 17% it would suffer a multiple reduction of its growth rate. Russia's higher rate of growth than the United States' (an average of 6.9% a year in 2003–2006) at almost the same rate of accumulation (18%) is accounted for by its lower acceleration coefficient, which is due to the fact that a considerable share of production growth in the Russian Federation was obtained with existing production capacities. In the future, as an increasing proportion of production growth requires new capacities, an increase in the acceleration coefficient is inevitable in Russia. According to our estimate, its value at a macro level should increase from 2.8 at present to 4.5–5.0 in the long term.

Both consumer demand and innovation motivation are critically dependent on labour wage reform in the production sphere. In fact, we must think about applying a market philosophy to the development of the wage package. What matters is that workers' wages must at least ensure the normal reproduction of labour. This is essential if they are to be a stimulus for the worker, a significant expenditure item for the employer, and, correspondingly, an important source of cost reduction. The labour market cannot perform well unless market-driven wages are sufficiently high. Besides, pay increases are essential for reducing the tax burden because greater motivation and labour intensity create the basis for the effective exchange of taxes for wages. The gist of the reform is to compel private business to make substantial pay rises in exchange for

[1] <http://www.economy.gov.ru>.

a reduction of their tax burden. Our target should be to try to increase wages at least twofold in the market sector of the economy over the next two-three years. The problem is, however, that any substantial increase in people's income means, other conditions being equal, an automatic reduction of resources for accumulation. Yet, reduced accumulation is impossible when unused capacities are close to depletion, while further economic growth depends on investment.

We assumed that, for the first five years of forecast, standard pay increased annually at a rate of 3–5 percentage points above nominal GDP dynamics. This growth would guarantee that the extra income of business due to the reduced tax burden would turn into household income, which will assure the growth of final demand in the economy.

Tax cuts, in part thanks to a blanket social tax rate, will lead to the legalization of shadow wages, which currently amount to more than 30% of official pay. Thanks to this factor, the additional growth in wages may amount to 4–5% a year. Besides, the redistribution of the economy's financial resources from government to business would, by itself, ensure additional annual growth of 5% or more. The rapid growth of minimum wages and the aforementioned redistribution of income would lead to wage increases outstripping labour productivity. At the early phases of the reform, given the need for the normalization of wages, this process may be considered perfectly natural. Besides, world experience shows the highly stimulating effect of a significantly rapid wage increase. While in this case the increase of labour productivity lags behind the increase in wages, the rate of growth of labour productivity may rise by an annual 7−8% or even 10% for a number of years, resulting in a cardinal change to the efficiency of the Russian economy. The pay rise elasticity of labour productivity (if its growth is not less than 10%) is approximately 0.7–0.8. This means that the real growth of wages at 10−12% a year may ensure a 7−9% increase in labour productivity. Based on 6–8% annual inflation and the above estimates of the implications of other wage normalization measures, the annual rise in wages over the next 5−7 years should be about 25−30%. Such a rapid growth of wages, even with unchanged inflation, in the context of the expected decrease in income differences, will keep domestic final demand at a high level and stimulate production growth.

The significant role of the energy sector in the Russian economy requires an in-depth analysis and forecasts of its future development (Table 1).

The main idea behind Russia's new energy strategy consists of liberating the natural gas resources consumed to generate electric power, and increase exports of the same. This would simultaneously involve the consumption of the huge existing stocks of coal. Thus, the share of atomic power generated would increase from 16.2% in 2006 to 30% by 2030, while the share of hydro-electric power would increase from 18.6 % to 20%, and the share of heat energy will decrease from 64.9% to 47%. In the generation of power from fossil sources of energy, coal will take the place of natural gas. The percentage of power stations burning fuel oil will fall from 4% to 3% of the total production of heat electric power generation, those burning gas, from 68% to 47%, and those burning coal will increase from 28% to 50%.

However, the essential growth of the share of coal in power generation will inevitably cause certain ecological consequences and will require additional investments in environmental protection.

Table 1. Base parameters of energy sector scenario.

	Structure of electric power production, %					
	2006	2010	2015	2020	2025	2030
Nuclear energy	16.2	18.4	21.4	24.3	27.1	30.0
Hydro energy	18.6	18.8	19.0	19.3	19.5	20.0
Solar energy	0.1	0.2	0.4	0.5	0.7	1.0
Renewable	0.3	0.6	0.9	1.2	1.5	2.0
Organic fuel	64.9	62.0	58.3	54.7	51.1	47.0
	Structure of electric power production on fossil fuel, %					
	2006	2010	2015	2020	2025	2030
Oil products	4.3	4.1	3.8	3.6	3.3	3.0
Gas	67.8	64.3	60.0	55.7	51.3	47.0
Coal	27.9	31.5	36.2	40.8	45.4	50.0

4. *The model and forecast for oil extraction and refining*

In order to make a long-term forecast of the development of the Russian oil industry we used a macroeconomic model which included financial as well as technological indicators. The main idea behind the tools developed consisted of considering the possibilities of increasing the volume of oil extracted and refined within the financial limits of industry.

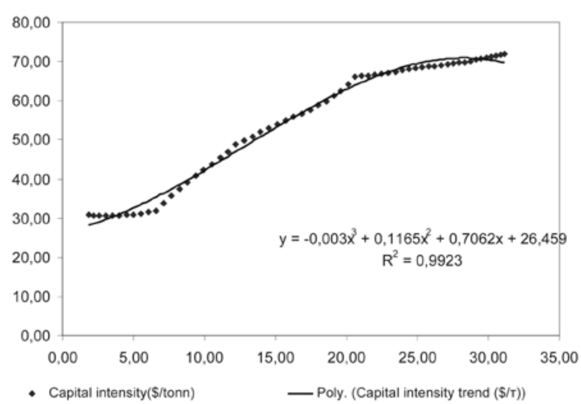
A general algorithm of calculation can be formulated as follows. We based our analysis on the technical characteristics of deposits developed in various geographical conditions, presented by the Ministry of Natural Resources of the Russian Federation and based on data provided by several oil companies. All the known and potential deposits were divided into 18 categories according to their estimated capital intensity. In addition, for each category, the expected amounts of available oil and operating costs were included (Table 2).

Table 2. Oil deposits, divided into categories by capital intensity.

Region	Category	Oil reserves, million tons	Capital intensity, \$/ton	Operating cost, \$/ton
Privolzhsky FD	I	157,6	42,0	75,4
	II	76,7	72,7	137,2
	III	192,4	94,5	213,5
North-western FD	I	2304,9	30,2	61,3
	II	825,7	50,1	110,1
	III	455,1	71,6	185,9
Southern FD	I	1037,1	36,0	78,2
	II	567,0	72,0	156,4
	III	322,8	108,0	254,6
Urals FD	I	8182,6	39,0	76,8
	II	4925,7	78,0	143,6
	III	3429,6	117,0	230,4
Siberia FD	I	765,2	49,7	89,6
	II	793,2	109,2	181,1
	III	1243,3	167,4	290,8
Far east FD	I	202,7	47,0	96,4
	II	114,4	78,0	173,6
	III	283,9	117,0	260,4
Shelf	I	477,0	104,8	175,7
	II	401,9	176,4	311,7
	III	1420,8	336,9	529,3

By knowing the sizes of the oil reserves and the extraction cost for each category, and assuming that cheaper deposits will be developed prior to expensive ones, we were able to estimate the increase of costs accompanying depletion of the cheaper deposits and the transition to more expensive oil deposits. This dependence can be shown in the form of a mathematical equation and used later in a production function of oil extraction (Fig. 5).

Figure 5. Capital intensity of the oil-extraction depending on volumes of the extracted petroleum as an accruing result from the beginning of the forecast period (the bottom scale, in billion tons).



In the same way a function describing the dependence of operating costs on the amounts of oil extracted was also formulated. This way we tried to reflect in our model that higher amounts of oil extraction lead to faster depletion of the cheap deposits and higher increases in capital intensity and operating costs.

Moreover, an attempt was made in the model to consider the investment lag caused by the transition to more remote deposits, also shown in the form of a function of the volumes of extracted oil. Consequently, the amount of extracted oil influences increases in capital intensity, operating costs and investment lags.

Domestic consumption of crude oil and petroleum products was calculated using exogenous indicators. For example, the demand for petroleum products was based on the dynamics of the vehicles in circulation, the ratio of diesel and petrol-fuelled cars circulating, the dynamics of air transportation, indicators of profitability indicators and operational loading on transport. Thus the production of petroleum products defines the internal demand for crude oil. The difference between oil extraction and internal consumption gives the resources available for export.

Internal prices for crude oil and petroleum products were estimated using exogenously preset world prices. First of all, the conventions for defining the internal prices of crude oil need to be understood as they are defined within the limits of vertically-integrated companies and have no clear market interpretation. As a result the model was initially based on set dynamics of oil prices in a scenario of changing export prices for mineral oil, and then proceeded to form a hypothesis of rapprochement of the world and domestic price dynamics of oil and mineral oil prices on the domestic market. As an indicator of the conformity of world and domestic price levels a price parity of 85%, approximately corresponding to price parity less export duties and transportation expenses, was used. The export prices were converted to roubles using exogenously preset exchange rates.

The production of crude oil and petroleum products was calculated as function of investment during previous years. In turn, investment was calculated from the financial result of industry. Pure financial gains were divided into three basic groups: investments in oil extraction, investments in oil refining and other distribution (which includes interest payments and investments in groups not connected with oil extraction and oil refining).

The total volume of investments in oil extraction was considered in the calculation of the production function. When forecasting the production of amounts of petroleum products it was assumed that the growth of investments in oil refining would lead to changes in its structure, with an increasing share of light petroleum products.

The model was solved using an iterative calculation procedure. On each iteration, current petroleum production and consumption and the dynamics of the world and domestic prices for crude oil and petroleum products were used to calculate the oil companies' gains. The parameters of the tax system and dynamics of operating costs then gave the pure financial result which, in turn, influenced the volume of investments in oil extraction and oil refining. In turn investment affects output and we returned to the first step of procedure until some equilibrium was found.

Using the complex model described we were able to make long-term forecasts of the development of the Russian energy sector. Thus, the increase in the average rate of investment for 2006-2030 will be 9.6%, and the period of the highest innovation and investment activity will be 2007- 2010, during which the economy will address the most important problems on overcoming constraints to economic growth in the infrastructural and processing sectors of the national economy (see Table 3). Household demand also is also one of the basic factors of economic growth. The annual increase in the rate of consumption by households will be 8.9% for 2006-2030. Total growth in the competitiveness of domestic production will cause an annual rate of reduction of imports from 20.2% in 2006-2010 to 5.4% in 2026-2030. The rate of growth in exports will be less than that of general economic dynamics, some acceleration being forecast only for the end of the forecast period. The annual rate of growth of exports for 2006-2030 will be 6.5%. In accordance with the dynamics of the elements of final demand, the average rate of GDP growth in the innovation option is 6.5%. In the sectoral composition of GDP in constant prices, it is worth noting the increase in the share of mechanical engineering from 6.9% in 2005 to 15.6% in 2030. Such a high increase is based, first of all, on the high level of investment activity in this area, after which the most intensive growth is in the share of the sub-sectors of the investment group. Simultaneously with this, a reduction in the share of the fuel and energy group sectors occurs in line with a conservative estimate of the increase in oil production. Among other sectors of industry, light industry shows a share which increases to 3.5% of the summary gross output by 2030. Innovation is determined by the considerable growth in the share of construction, this sector becoming one of the most significant sectors of the national economy. By 2030, it will account for 10% of gross output in 2002 prices. In a situation of accelerated economic growth, the role of infrastructural sectors increases with substantial growth in the share of communication services from 1.5% in 2005 to 6.3% in 2030. The share of transport will be 8.2% in 2030.

Table 3. Average annual rate of growth of GDP and basic elements of final demand, %.

	2006-2010	2011-2015	2016-2020	2021-2025	2026-2030
Household	12.5	11.2	9.6	7.7	5.7
Government	5.0	4.7	4.4	4.0	3.6
Fixed capital investment	16.0	13.6	11.3	7.8	4.3
Export	6.1	5.8	5.7	6.3	10.1
Import	20.2	16.0	12.1	8.3	5.4
GDP	7.0	6.4	6.2	6.1	6.7

As for the production of different energy resources (Table 4), the amount of oil extraction will increase up to 530 million tons in 2020 and then fall to 479 million tons almost equal to the 2006 level. This will inevitably cause a 25% fall in crude oil exports. The amount of natural gas production will increase to 1019 billion m^3, which is 1.5 times higher than the 2006 level, while exports will increase by more than 2.5 times reaching 578 billion m^3. The strategy of power generation development provides for large increases in the volume of coal generated. According to our calculations, this means, as we said, that by the end of the forecast period coal production (compared to the persistence of current trends) would increase by 136 million tons. This will cause coal production to increase to 471 million tons, while coal exports will remain at almost the same level as 2006. Despite essential economic growth, electric power production will increase only by 2.5 times (up to 2454), this is explained by the reduction of more than 40 % in the energy intensity of gross domestic product.

Table 4. Production and export of energy resources.

	2005	2010	2015	2020	2025	2030
Oil, mln.t.						
Extraction	470	509	529	530	513	479
Export	262	281	286	275	250	211
Share of export	55.7%	55.2%	54.1%	51.9%	48.7%	44.1%
Gas, bln. м.cub.						
Extraction	638	725	820	904	972	1019
Export	207	272	367	447	515	578
Share of export	32.4%	37.5%	44.8%	49.4%	53.0%	56.7%
Coal, mln.t.						
Extraction	298	345	400	453	487	471
Export	80	87	89	86	80	70
Share of export	27.0%	25,1%	22.1%	19.0%	16.4%	14.9%
Electricity bln. kW-h						
Production	952	1147	1384	1683	2035	2454
Export	18	27	29	35	46	74
Share of export	1.9%	2.4%	2.1%	2.1%	2.3%	3.0%

The development of the energy sector and, especially, the substitution of coal for natural gas in power generation creates significant pressure on the environment. A solution to this problem is the technological improvement of the power plants used and the installation of clearing facilities. With this view a forecast of greenhouse gas emission thus becomes significant.

The main input parameters for calculations of greenhouse gas emission are:

1. the dynamics and structure of economy;
2. the dynamics and structure of export and import flows;
3. changes in technological progress and energy efficiencies;
7. the dynamics and structure of transport;
8. the composition of the vehicles in circulation;
9. the volumes of energy consumption (by kinds of source);
10. the power generation structure, especially the share of nuclear and hydraulic power, and also the share of other non-fossil power sources;
11. the dynamics of the costs of fuel in power stations.

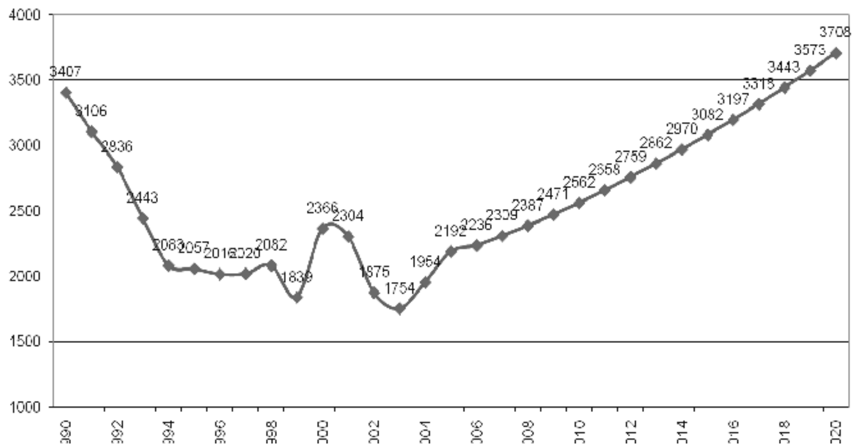
All these parameters are used in the CONTO modelling system depending on the macro-economic development scenarios.

As for the exogenous variables of the model directly connected with calculation of greenhouse gas emission, these must include primarily all the following:

1. the specific caloric content of the fuel;
2. factors of issue both related to the various technologies of burning fuel and the various physical, chemical and biological processes used in industry and agriculture;
3. the potential characteristics of new, alternative energy sources;
4. the characteristics of technologies for clearing greenhouse gas;
5. the characteristics of technologies for gathering and depositing greenhouse gas emissions.

Using the long-term forecast of the Russian economy the amount of greenhouse gas emissions (Figure 6) was estimated. The fall in production was the main reason for the decrease of emissions in the 90's and created some reserves for the following years. This allowed Russia to develop coal-based power generation, which is «dirtier» than other types of electricity generation. The lack of investment in the 90's also created the need for significant changes to the old, reduced efficiency capital funds, which are Russia's second option for fighting pollution. The use of «green field» technology in coal-based power generation enables Russia to remain almost within Kyoto protocol limits reaching base level (1990) only in 2018 and exceeding it later by no more than 10%. But such measures also cause significant increase in capital costs of new power plants and government support of coal-based power generation is required.

Figure 6. Greenhouse gases emission – mln. T. CO_2 equivalent.



Conclusions

1) Our calculations are an addition to the government's long term forecast , rather than a criticism of such, the use of inter-industry models enabling us to estimate economic and environmental parameters more precisely.
2) The energy balance model combined with the inter-industry model made it possible to estimate internal demand for all kinds of energy resources and the amount available for exports.
3) The results of the model show that changes in the structure of power generation in favour of coal-based generation make it possible to satisfy rising internal electricity consumption and to increase exports of natural gas, enabling Russia to remain a main exporter of natural gas on the worldwide and European markets.
4) Despite high rates of growth of the economy and the increasing share of coal-based power generation, greenhouse gas emission will only reach the 1990 level in 2018 due to the improved energy efficiency of the economy.

References

Shirov A.A. and A.A. Yantovsky (2008), Coordination of Sectoral Strategies as an Element of a Comprehensive National Economic Forecast: The Case of Power Engineering and Railroad Transport. *Studies on Russian Economic Development*, 2008, Vol. 19, No. 5, pp. 452–464.

Uzyakov M.A (2006), Quarterly Forecast of the Russian Economic Macroindicators 2006–2008: A Baseline Scenario. *Studies on Russian Economic Development*, 2006, Vol. 17, No. 4, pp. 345–364.

A STUDY OF THE EFFECTS OF ENERGY SAVING ON THE CHINESE ECONOMY USING THE MUDAN MODEL

Pan Shengchu, Fei Mingshuo
Central University of Finance and Economics, Beijing, China

China's economy has been developing rapidly since the 1980s. However, the high rate of development has been accompanied by high energy consumption. Energy consumption per unit GDP in China is much higher than in developed countries. This situation will not permit sustainable development in the future. In order to solve this problem, the Chinese government set a target to reduce energy consumption by 20% in the 11th five year plan from 2006 to 2010. In this paper we have used the Mudan model to simulate a number of experiments and study the effects of energy saving on China's economy.

1. The Mudan Model

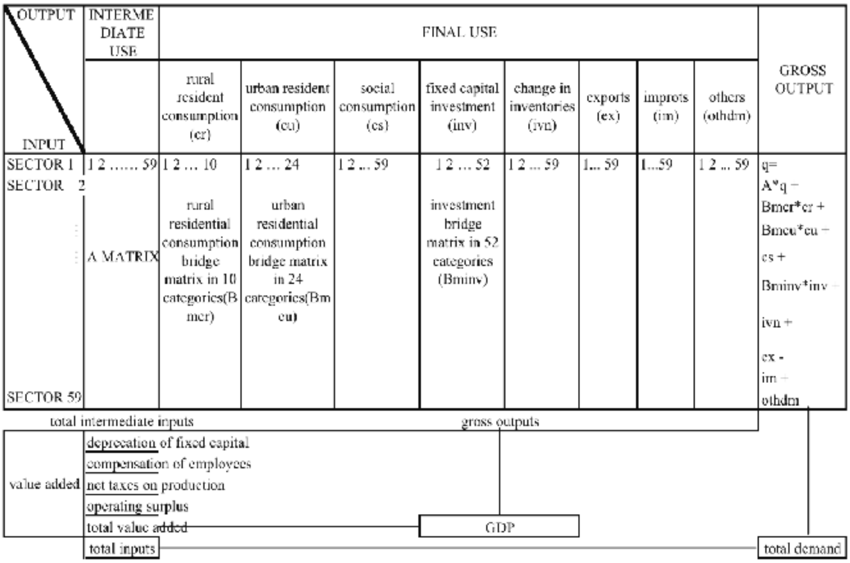
Mudan is a Multisectoral dynamic model of the Chinese economy, based on a 59-sector I-O table. Its Input-output structure is described in Fig. 1. At the top-left of the table is a matrix named A, which is a 59x59 matrix of intermediate products. The rows represent intermediate input, while the columns represent intermediate uses. The figures in each cell have a double meaning: horizontally they represent the volume of goods or services that the sector consumes in the production process, and vertically they represent the amount of products or services that the output sector produces for each input sector as intermediate use.

Right of the A matrix are the various components of final use such as rural residential consumption, urban residential consumption, social consumption, fixed capital investment, change in inventories, imports, exports and other final demand. The sums of each row of the table represent the total demand of each sector.

Beneath the A matrix are items of value added (initial input), including wages, depression, taxes and profits. The sum of each sector's intermediate input and value added gives the sector's total input, which is equal to the total demand of each sector.

Maurizio Grassini and Rossella Bardazzi (edited by), *Energy Policy and International Competitiveness*,
ISBN 978-88-6453-040-6 (print) ISBN 978-88-6453-043-7 (online)

Figure 1. I-O Framework of the Mudan model.



The corresponding production side I-O Equation is:

$$A \times q + Bmcr \times hcrT + Bmcu \times hcuT + Bminv \times inv + cs + ivn + ex - im + othdm = q$$

where:

- A = I-O is the input coefficient matrix, 59×59
- q = gross output, 59×1
- Bmcr = bridge matrix for rural household consumption, 59×10
- hcrT = rural household consumption by 10 categories, 10×1
- Bmcu = bridge matrix for urban household consumption, 59×24
- hcuT = urban household consumption by 24 categories, 24×1
- Bminv = bridge matrix for investment in fixed-assets, 59×52
- inv = investment in fixes-assets, 52×1
- cs = government expenditure, 59×1
- ivn = inventory changes, 59×1
- ex = exports, 59×1
- im = imports, 59×1
- othdm = other final demand, for statistical error adjustment purposes, 59×1

All the above components are in constant prices. Consumption, investment, exports and imports are calculated separately based on behavior equations, and then a *seidel* procedure is used to compute gross output.

There are three modules in Mudan, the production module, the price-income module and the accounting module.

In the production module, each sector's final demand data in constant prices are calculated, including residential consumption, social consumption, fixed assets investment, storage, imports, exports and other final demand. Then, the I-O equation computes the total output of each sector. Finally, we get productivities and employment.

The Price-income module calculates each sector's value added, including wages, depreciation, profits and taxes. All the data in the price-income module are nominal. Price indexes are computed in this module too.

The Accounting module plays a role as national economy accountant. It generates price indexes for aggregated data through weighted averages, it computes rural and urban residential income, and nominal GDP and GDP in current prices.

2. *Simulation experiments*

We performed two simulation experiments to study the effects of energy saving on China's economy using the Mudan model. The simulations were as follows.

1. Reducing energy consumption.
2. Improving the efficiency of transport fuel.

Simulation 1: Reducing energy consumption

In China's 11th five year plan, the government plans to reduce energy consumption by 20% per unit GDP. Coal, crude oil and natural gas are China's main energy resources, composing 94.2% of China's total energy consumption. So the simulation studies the effects of reducing the consumption of coal, crude oil and natural gas.

The input coefficients of the Mudan model reflect the input-output connections of all 59 industrial sectors. Reducing energy consumption means that the input coefficients of sector 5 (coal mining) and sector 6 (Crude petroleum and natural gas production) to all 59 sectors are reduced. We can simulate the effect of reducing energy consumption by changing the input coefficients of these sectors to the 59 sectors.

In the base run, we kept the input coefficients of sector 5 and sector 6 to the 59 sectors at the current level. In the simulation run, we decreased the input coefficients of sector 5 and sector 6 to the 59 sectors by 4% every year from 2006 to 2010. The results of this simulation are shown in Table 1.

Table 1. Effects of Reducing energy consumption.
Unit: 100 million Yuan

Index (real)		2006	2007	2008	2009	2010	2006 percent change	2007 percent change	2008–2010 percent change
GDP	Base run	95858.9	106595	117574.3	129684.4	143041.9	11.2	11.5	10.2
	Simulation	96981.3	119011.2	123411.5	145211.4	149031.9	11.6	12.0	10.8
Urban Consumption	Base run	26974.8	30400.5	34079.0	38202.5	42825.0	12.7	12.9	12.1
	Simulation	27484.2	31983.1	34991.0	39345.1	43134.1	13.0	13.3	12.6
Rural Consumption	Base run	12744.0	13941.9	15127.0	16412.8	17807.8	9.4	9.1	8.5
	Simulation	13345.2	14293.8	16983.1	17990.2	18489.3	9.7	9.8	9.2
Fixed Investment	Base run	40572.3	44832.4	49539.8	54741.5	60489.3	10.5	10.7	10.6
	Simulation	42234.9	45873.1	50938.3	55903.1	61583.1	10.9	11.3	11.1
Export	Base run	28514.8	31851.0	35290.9	39102.3	43325.4	11.7	11.3	10.8
	Simulation	29342.2	32345.3	36903.3	41239.3	45329.4	12.1	12.3	11.6
Import	Base run	24492.4	27284.5	30380.4	33838.5	37717.2	11.4	11.6	11.9
	Simulation	24313.3	26731.2	28932.1	32328.2	36733.1	11.1	11.2	11.1
Rural CPI	Base run	2.23	2.26	2.30	2.33	2.36	1.3	2.2	2.6
	Simulation	2.20	2.19	2.22	2.30	2.31	1.1	1.9	2.3
Urban CPI	Base run	2.30	2.34	2.38	2.42	2.46	1.5	2.3	2.7
	Simulation	2.28	2.31	2.34	2.38	2.41	1.3	2.0	2.3
Employment	Base run	76391.2	76971.8	77532.4	78091.1	78712.9	0.76	0.74	0.76
	Simulation	76673.3	77231.4	77871.1	78349.2	78989.9	0.78	0.77	0.79
Oil Demand	Base run	2108.9	2345.1	2586.6	2853.1	3146.9	11.4	11.5	11.8
	Simulation	1898.1	2063.7	2198.6	2197.9	2311.2	5.7	10.7	9.6
Oil Import	Base run	695.9	773.9	853.6	941.5	1038.5	11.2	11.5	11.9
	Simulation	612.4	657.8	708.5	620.1	762.6	5.0	9.3	8.7

Table 2. Improving the efficiency of transport fuel.
Unit: 100 million Yuan

Index (real)		2006	2007	2008	2009	2010	2006 percent change	2007 percent change	2008–2010 percent change
GDP	Base run	95858.9	106595	117574.3	129684.4	143041.9	11.2	11.5	10.2
	Simulation	96738.1	112231	119174.3	139385.4	147321.9	11.3	11.7	10.6
Urban Consumption	Base run	26974.8	30400.5	34079.0	38202.5	42825.0	12.7	12.9	12.1
	Simulation	27213.2	31230.3	34892.0	39212.9	43213.0	12.8	13.0	12.3
Rural Consumption	Base run	12744.0	13941.9	15127.0	16412.8	17807.8	9.4	9.1	8.5
	Simulation	13185.1	14361.2	16142.8	17523.8	18276.2	9.5	9.3	8.8
Fixed Investment	Base run	40572.3	44832.4	49539.8	54741.5	60489.3	10.5	10.7	10.6
	Simulation	41972.2	45276.4	50182.2	55627.3	61238.7	10.7	10.9	10.9
Export	Base run	28514.8	31851.0	35290.9	39102.3	43325.4	11.7	11.3	10.8
	Simulation	29172.1	32348.2	36782.3	40982.5	44672.8	11.8	11.4	10.9
Import	Base run	24492.4	27284.5	30380.4	33838.5	37717.2	11.4	11.6	11.9
	Simulation	24382.8	26902.9	29087.1	32677.5	36892.9	11.3	11.4	11.6
Rural CPI	Base run	2.23	2.26	2.30	2.33	2.36	1.3	2.2	2.6
	Simulation	2.21	2.24	2.28	2.31	2.34	1.2	2.1	2.4
Urban CPI	Base run	2.30	2.34	2.38	2.42	2.46	1.5	2.3	2.7
	Simulation	2.29	2.33	2.36	2.39	2.42	1.4	2.2	2.5
Employment	Base run	76391.2	76971.8	77532.4	78091.1	78712.9	0.76	0.74	0.76
	Simulation	76428.3	77081.4	77612.9	78142.1	78934.9	0.77	0.76	0.78
Oil Demand	Base run	2108.9	2345.1	2586.6	2853.1	3146.9	11.4	11.5	11.8
	Simulation	1687.1	1876.3	2043.3	2197.9	2391.2	5.9	10.2	9.8
Oil Import	Base run	695.9	773.9	853.6	941.5	1038.5	11.2	11.5	11.9
	Simulation	450.8	501.4	557.6	620.1	689.5	5.1	9.5	8.9

From the simulation, we reached the following conclusions.

1. Reducing energy consumption would promote a higher rate of growth of China's economy. The growth rates of GDP in the simulation run are 0.4, 0.5 and 0.6 points higher than those in the base run for 2006, 2007 and 2008-2010 respectively.
2. Another effect of reducing energy consumption would be the fall in the rate of inflation. Rural CPI in the simulation run is 0.2, 0.3 points below the base run in 2006 and 2007, and an average 0.3 points below base run from 2008 to 2010. Urban CPI in the simulation is 0.2, 0.3 points below the base run in 2006 and 2007, and an average 0.4 points below the base run from 2008 to 2010.
3. Reducing energy consumption could reduce the import and consumption of crude oil. The consumption of crude oil is 2.2 points below the base run from 2008 to 2010 on average. The import of crude oil is 3.2 points below the base run from 2008 to 2010.

Simulation 2: Improving the efficiency of transport fuel

The rising price of crude oil is a big problem for the transportation sector. The way to solve this problem is to improve the efficiency of transport fuel.

Improving the efficiency of transport fuel in the model can be shown by changing the input coefficients of the petroleum processing, coking and nuclear fuel processing sectors to transportation sectors.

In base run, we kept the input coefficients of sector 22 (Petroleum refineries and coking products), sector 47 (Highway transportation) and sector 49 (Air transportation) at the current level. In the simulation run, we decreased the input coefficients of sector 22 to the transportation sectors by 10% every year from 2006 to 2010. The results of this simulation are shown in Table 2.

The conclusions are as follows.

1. Improving the efficiency of transport fuel could promote a faster rate of growth of China's economy. The growth rates of GDP in the simulation run are 0.1, 0.2 and 0.4 points higher than those in the base run in 2006, 2007 and 2008-2010 respectively.
2. Another effect of improving the efficiency of transport fuel is a slight fall in inflation. Rural CPI in the simulation run is 0.1, 0.1 points below the base run in 2006 and 2007, and an average 0.2 points below the base run from 2008 to 2010. Urban CPI in the simulation is 0.1, 0.1 points below the base run in 2006 and 2007, and an average 0.17 points below base run from 2008 to 2010.

3. Improving the efficiency of transport fuel could reduce the import and consumption of crude oil. The consumption of crude oil is 2.0 points below the base run from 2008 to 2010 on average. The import of crude oil is 3.0 points below base run from 2008 to 2010 on average.

Appendix

The 59 sectors of the Mudan model.

1 Farming
2 Forestry
3 Livestock
4 Fishing
5 Coal mining
6 Crude petroleum and natural gas production
7 Ferrous ore mining
8 Non-ferrous ore mining
9 Non-metal minerals mining and mining, n.e.c.
10 Logging and transport of timber and bamboo
11 Food processing and manufacturing
12 Beverages
13 Tobacco manufacture
14 Textiles
15 Wearing apparel
16 Leather, fur and their products
17 Sawmills and bamboo etc. products
18 Furniture
19 Paper and paper products
20 Printing industries
21 Cultural, education, sports articles
22 Petroleum refineries and coking products
23 Chemical industries
24 Medicines
25 Chemical fibres
26 Rubber products
27 Plastic products
28 Building materials and non-metallic mineral products, n.e.c.
29 Primary iron and steel manufacturing
30 Primary non-ferrous metals manufacturing
31 Metal products
32 Machinery
33 Railroad equipment
34 Motor vehicles
35 Shipbuilding
36 Aircraft
37 Transportation equipment, n.e.c.
38 Electric machinery and equipment
39 Electronic and communication equipment
40 Instrument, meters and other measuring equipment
41 Manufacture, n.e.c.
42 Electricity, steam and hot water production and supply
43 Gas production and supply
44 Production and supply of water
45 Construction
46 Railway transportation
47 Highway transportation
48 Water transportation
49 Air transportation
50 Transport, n.e.c.
51 Communications

52 Commerce
53 Restaurants
54 Finance and insurance
55 Real estate, and social services
56 Health care, sports and social welfare
57 Education, culture, arts, radio, film and television
58 Scientific research and poly-technic services
59 Public administration and others

References

Meyer Bernard (2007). Oil Price, GDP and International Trade: The Case of Germany. 15th INFORUM World Conference.

Nyhus Douglas (2007). Closing China's Trade Surplus. 15th INFORUM World Conference.

Werling Jeff (2007). LIFT Model of the U.S. Economy: Long Term Economic Impact of Energy Policies. 15th INFORUM World Conference.

COMPETITIVENESS AND COUNTRY MODELS

THE COMPETITIVENESS OF MANUFACTURING BRANCHES IN LATVIA: AN INTERNATIONAL COMPARISON WITH ANALYSIS AND FORECASTS

Remigijs Počs, Astra Auziņa, Velga Ozoliņa
Riga Technical University, Latvia

Gunta Piņķe
Ministry of Economics of Republic of Latvia

Issues related to global, sectoral, and business competitiveness are topical all over the world, including in the new European Union (EU) member states with fast growing economies, such as Latvia. Since joining the EU in 2004, the average annual growth rate of gross domestic product (GDP) in Latvia was 11%, and, in 2007, it was 10.3%, the highest rate of growth among the EU member countries. Experts believe that the rapid economic development of these years is the consequence of a productivity increase.

Given the present situation, where the annual growth of the economy is determined mainly by the development of service sector industries (wholesale and retail trade; real estate, rental and business activities; transport and communications; financial intermediation etc.), the issues related to the manufacturing sector and its current and further development have become extremely topical and deserve exhaustive study and analysis.

This paper is about the Latvian manufacturing sector, its present trends and structure, its share in the economy and further development trends, bearing in mind competitiveness issues.

1. *Analysis of concept of competitiveness*

Competitiveness is a considerably new concept and represents the ability of a country, sector, or business to compete and maintain its positions in the market. The concept of competitiveness is a composite concept that includes a number of divisions and covers different and various aspects to reach its goal.

Many authors stress that the concept of competitiveness is an elusive concept (Grilo *et al.*, 2006), which is difficult to measure (Bronisz *et al.*, 2008) and have proposed new or upgraded definitions of this concept, carrying out detailed analysis and clarifying the current definitions. However, one must admit that there is no one widely-recognised definition but many similar definitions contemporarily accepted by some or many specialists.

Maurizio Grassini and Rossella Bardazzi (edited by), *Energy Policy and International Competitiveness*,
ISBN 978-88-6453-040-6 (print) ISBN 978-88-6453-043-7 (online)

M.E. Porter, who is one of the world's leading specialists in competitiveness issues, defines the competitiveness of a location as the productivity that the companies located there can achieve (Porter 1990; Ketels 2006). Productivity is the key determinant of the level of prosperity (created not inherited) a location can sustain over time.

Fisher and Schornberg (2006) define competitiveness as a construct (i.e., a composite concept), covering relative and multidimensional economic performance as indicated by profitability, and productivity as output growth. The authors stress the importance of distinguishing competitiveness indicators from competitiveness determinants.

In some studies (Kohler-Toglhofer *et al.* 2007), authors focus more on cost competitiveness and apply various indicators and indexes elaborated on the basis of cost/price indexes.

Sirikrai and Tang (2006), who analyse industrial competitiveness, argue that financial and non-financial indicators are widely used and that the combination of financial and non-financial indicators ensures a more detailed analysis of organizational performance, which, in turn, leads to a more meaningful analysis of industrial competitiveness. Hence the competitiveness of firms within a particular industry therefore reveals the competitiveness of that industry, and it is of utmost importance to separate competitiveness indicators from competitiveness drivers. In a practical application to Thailand's economy, five industrial competitiveness indicators were identified, which are considerably general and can therefore be applied to other economies: manufacturing excellence, the value-added of products, market expansion, financial returns and intangible values.

Despite the problems revealed regarding the definition of the concept of competitiveness, authors have elaborated theoretical and practical aspects of this sphere in more detail as the classification, factors or drivers of competitiveness. One way of eliminating some of the problems regarding the definition and facilitating further theoretical research and a practical application process is to classify several levels or objects of competitiveness. Some authors (for example, Drescher *et al.* 1999) define three levels of competitiveness: the competitiveness of companies (microeconomic level), the competitiveness of industries (mesoeconomic level), and the competitiveness of national economies (macroeconomic level). This subdivision is applied in practice as it makes the concept easier to understand and facilitates studies and practical elaborations of the tools and methods used.

Nowadays, various organisations prepare and publish a variety of reports evaluating countries' regional and sectoral competitiveness. In most cases, each of these reports contains a set of indicators representing the situation as regards competitiveness. It is clear that more attention is paid to the competitiveness of nations while sectoral competitiveness, globally and within the country, is analysed less intensively. At the same time, some authors have carried out elaborate analyses of the competitiveness of a specific sector or sectors, such as the food industry, meat production etc. These studies are focused only on this specific industry, consequently less or no attention is paid to other sectors.

The IMD Word Competitiveness Yearbook (WCY) and The Global Competitiveness Report (GCR) are leading reports on the state of global competitiveness and its changes. Despite the focus of these reports, they use and integrate different indicators, cover different numbers of countries etc., and also use dissimilar definitions

According to the definition presented in the WCY 2008, the competitiveness of nations is a field of economic knowledge which analyzes the facts and policies that shape the ability of a nation to create and maintain an environment that sustains the creation of more value for its enterprises and more prosperity for its people. This means that competitiveness analyzes how nations and enterprises manage the totality of their competencies to achieve prosperity and profit. Some nations support competitiveness more than others by creating an environment that facilitates the competitiveness of enterprises and encourages long-term sustainability. At the same time, in the GCR 2008-2009 competitiveness is defined as the set of institutions, policies, and factors that determine the level of productivity of a country. The level of productivity, in turn, sets the sustainable level of prosperity that can be achieved by an economy. In other words, more competitive economies tend to be able to produce higher levels of income for their citizens. The productivity level also determines the rates of return achieved by investments in the economy. Because the rates of return are the fundamental determinants of the growth rates of the economy, a more competitive economy is one that is likely to grow faster over the medium to long run. The concept of competitiveness thus involves static and dynamic components: although the productivity of a country clearly determines its ability to sustain a high level of income, it is also one of the central determinants of the returns to investment, which is one of the key factors explaining an economy's growth potential.

As for applied criteria and the number of countries covered by the reports, the WCY ranks the 55 countries on the basis of 331 criteria, this includes the criteria used to compute the rankings, which are grouped into 4 main factors (economic performance, government efficiency, business efficiency, infrastructure) divided into 20 sub-factors. Business efficiency covers such fields as productivity, the labour market, finance, management practices, attitudes and values. Furthermore, the sub-factors of productivity and efficiency are: overall productivity, real productivity growth, labour productivity and its growth, productivity in agriculture, industry, services, large corporations, small and medium-size enterprises and the productivity of companies. However the GCR ranks 134 economies[1] and includes relative rankings for more than 100 variables. The index used (Global Competitiveness Index 2008-2009) contains three sub-indexes relating to basic requirements (such as institutions, infrastructure, macroeconomic stability, health and primary education), efficiency enhancers (such as labour market efficiency, market size etc.), and innovation and sophistication factors. This index was developed by Xavier Sala-i-Martin (Columbia University). The report also contains The Business Competitiveness Index, which was developed by Michael E. Porter (Harvard Business School).

Both of the above-mentioned publications give an important insight into national competitiveness and indicate the changes occurring (gain or loss of competitiveness). On the other hand, these reports only offer overall characteristics of a country's level or status regarding competitiveness, at the same time, taking into account the rankings of other, especially neighbouring countries.

In practice, statistical bureaus and other institutions compute various indicators regarding competitiveness and productivity. Mostly these indicators cover such fields as outcomes, investment, innovation, skills, enterprises and competition. Outcome indicators such as value added per worker and value added per hour worked are some of the key indicators that are widely-used and recognised.

Regarding the analysis performed and evaluations of Latvian sectoral competitiveness, so far, the major focus has been on overall issues or very specific issues and theoretical aspects, omitting numerical results in most cases (Vanags I. *et al.* 2004; Vanags A. *et al.* 2005; Kasalis 2004).

This paper focuses on sectoral competitiveness and hence, due to the limiting factors and conditions, it emphasises productivity and growth indicators more (regarding the competitiveness of industries (at a mesoeconomic level)) and other indicators such as profitability, investment, skills and education, innovation, less.

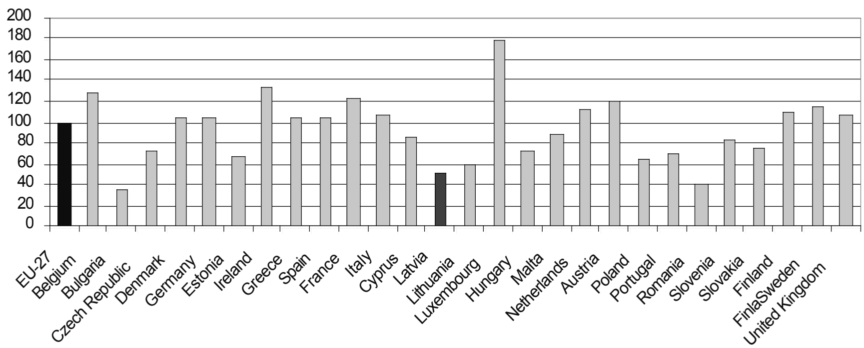
2. Analysis of trends

Although Latvia has experienced high economic growth rates since 2000, especially in the past few years, its labour productivity in 2007 was one of the lowest among the EU-27 countries (see Figure 1). It account-

[1] According to the Global Competitiveness Index (GCI) Latvia was in 54th place in the 2008-2009 edition, in 45th place in the 2007-2008 edition, but in 44th place in the 2006-2007 edition (straightforward conclusions regarding the worsening of Latvia's competitiveness cannot be made based on these numbers, because the number of countries included in the survey has increased). The neighbouring countries (Estonia, Lithuania) have a higher position in this ranking – respectively 32nd (27th; 26th) and 44th (38th; 39th) place, in the 2008-2009 (2007-2008; and 2006-2007) editions.

ed for only 53.6% of average productivity in the EU-27. However, productivity in Latvia has grown significantly in recent years, for example, compared to 2000, it has grown by 68%. During this period, productivity growth was only higher in Estonia (83%) and in Lithuania (78%) while average productivity in the EU-27 countries grew only by 25%.

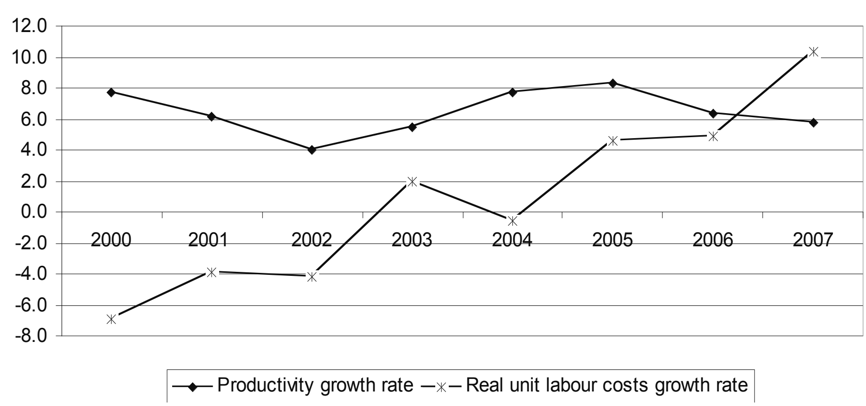
Figure 1. Labour productivity per person employed - GDP in Purchasing Power Standards (PPS) per person employed relative to EU-27 in 2007 (EU-27 = 100).



Source: Eurostat

Productivity is often analysed together with labour costs in order to show, whether the increase in labour costs is justified by equal or higher productivity growth. Using real unit labour costs and real output per employee, we can see that in 2000–2006 the productivity growth rate was higher than the unit labour costs growth rate. However, in 2007, unit labour costs increased 4.5% faster than productivity.

Figure 2. Dynamics of productivity and labour costs in Latvia (%).



Source: CSB database

To improve the overall productivity level in Latvia, it is important to concentrate on the key branches of the economy. As productivity is directly connected with employment, the major industries are to be analysed from the point of view of the number of employees. The data in Table 1 show that the most important industries as regards the number of employees, are trade, manufacturing, construction, agriculture and transport and communications. Manufacturing is considered to be the key industry as a major driving force of Latvian exports, comprising more than half of the same (56.6% of exports of goods and services in 2007).

Table 1. Latvian industry structure, productivity and labour costs in 2007.

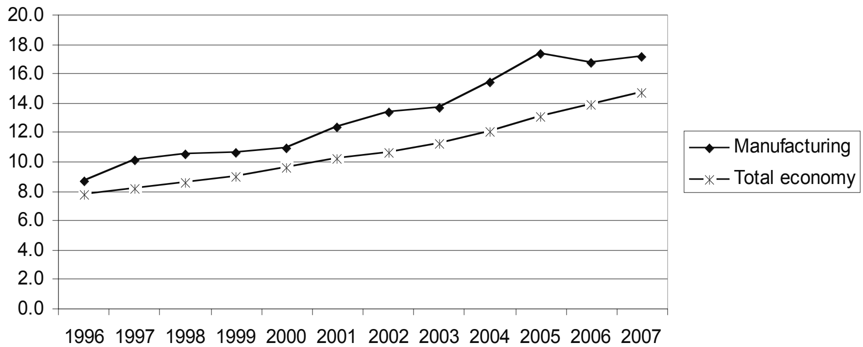
Industry	Output (%)	Employment (%)	Productivity (thsd Ls)	Labour costs per employee (thsd Ls)
Agriculture	3.6	9.7	5.5	0.9
Fishing	0.1	0.3	7.0	2.0
Mining and quarrying	0.4	0.6	10.5	2.4
Manufacturing	17.2	14.8	17.2	4.6
Electricity, gas and water supply	3.2	1.9	25.2	6.0
Construction	10.1	11.3	13.2	3.6
Trade	20.7	16.6	18.5	4.6
Hotels and restaurants	2.1	2.8	11.3	3.2
Transport and communications	14.7	9.3	23.2	4.7
Financial intermediation	4.2	2.0	31.7	11.8
Real estate	11.3	6.6	25.1	7.3
Public administration	4.0	7.5	7.9	7.8
Education	2.5	7.3	5.0	6.6
Health and social work	1.8	4.5	5.8	6.0
Other activities	4.0	4.8	12.2	4.5
Total economy	100.0	100.0	14.7	5.3

Source: CSB database

It is worth mentioning that industries with higher productivity (expressed as real output to the number of employees) also have higher labour costs (see Table 1) and industries with lower productivity – lower labour costs (with the exception of public administration, education and health and social work, which are usually considered as public sector provided services). This may indicate that wages are an important motivator in the private sector, but not as important in the public sector.

An analysis of productivity shows that manufacturing is one of the industries with the highest productivity in the whole economy. However, it is only half as large as financial intermediation. A positive trend in manufacturing is its constant increase in productivity (except in 2006), as seen in Figure 3. During 1996–2007 productivity in manufacturing almost doubled, growing on average 6.4% a year, which is more than overall productivity growth (on average 6% a year).

Figure 3. Dynamics of output per employee (thsd LVL)



Source: CSB database

Over the last few years, Latvia has faced some serious problems associated with the workforce. For example, the number of vacant workplaces in manufacturing grew from 1.1% in 2005 to 2.3% in 2007. As a result, other means of action were implemented, including the increase of salaries, which may cause disparities in the growth of labour costs and productivity.

An analysis of detailed data on manufacturing, which are shown in Table 2, shows that leading branches, both regarding production and employment, are the manufacture of food products and beverages and the manufacture of wood and wood products. Other significant branches regarding employment are the manufacture of furniture, manufacture of wearing apparel, publishing, printing and reproduction of recorded media, manufacturing of fabricated metal products and manufacture of textiles. An increase of productivity in these branches would ensure the highest increase of productivity in the manufacturing industry and overall economy.

Table 2. Latvian manufacturing structure, productivity and labour costs in 2007.

Branch (NACE)	Production value (%)	Employment (%)	Production value per employee (thsd LVL)	Personnel costs per employee (thsd LVL)
Manufacture of food products and beverages (D15)	23.8	20.8	36.4	4.5
Manufacture of textiles (D17)	2.4	4.3	17.7	3.9
Manufacture of wearing apparel (D18)	2.3	7.1	10.3	3.2
Tanning, dressing of leather (D19)	0.1	0.3	11.6	2.7
Manufacture of wood and of wood products (D20)	21.7	19.1	36.0	4.2
Manufacture of pulp, paper and paper products (D21)	1.3	1.0	39.6	5.7
Publishing, printing, reproduction of recorded media (D22)	5.3	6.9	24.5	5.2
Manufacture of chemicals and chemical products (D24)	2.6	2.7	30.8	6.9
Manufacture of rubber and plastic products (D25)	3.7	3.0	39.7	5.1
Manufacture of other non-metallic mineral products (D26)	6.5	4.5	46.1	6.2
Manufacture of basic metals (D27)	6.3	2.3	87.5	7.7
Manufacture of fabricated metal products (D28)	6.1	6.5	29.8	4.7
Manufacture of machinery and equipment n.e.c. (D29)	2.9	4.2	22.3	4.8
Manufacture of office machinery and computers (D30)	0.5	0.1	153.2	8.5
Manufacture of electrical machinery and apparatus n.e.c. (D31)	2.3	2.6	28.2	7.0
Manufacture of radio, television and communication equipment and apparatus (D32)	0.6	0.7	29.3	5.9
Manufacture of medical, precision and optical instruments (D33)	0.9	1.1	26.5	5.4

Manufacture of motor vehicles, trailers and semi-trailers (D34)	1.3	0.8	49.4	6.7
Manufacture of other transport equipment (D35)	2.8	3.5	24.9	5.6
Manufacture of furniture; manufacturing n.e.c. (D36)	4.3	7.7	17.6	3.8
Recycling (D37)	1.7	0.5	109.9	4.3
Manufacturing (D)	100.0	100.0	31.8	4.8

Source: CSB database

Data in Table 2 show that the production value per employee in two leading branches as well as seven minor branches (regarding employment) is higher than average in the manufacturing industry. However, one cannot unambiguously declare that it is easier to enhance productivity in branches with lower productivity than average. Only specialists in particular branches can evaluate how wage increases or additional investments might improve productivity. For example, in branches like the manufacture of fabricated metal products, manufacture of transport equipment or manufacture of furniture, an increase in investment generates a considerably lower increase in productivity, but in branches like the manufacture of textiles, manufacturing of wearing apparel and manufacturing of wood and wood products the difference is not as significant.

An analysis of investment also shows that since 2004 higher investment growth has been associated with high and medium technology manufacturing branches: the average annual increase in high technology branches was 30%, in medium technology branches – 38% and in low technology branches – 5.5%. In 2007 the investment in high technology branches grew by 26% and accounted for 13% of all investment in manufacturing. Such trends might indicate capital saturation in low technology branches and the diminishing growth potential of these branches influenced by competition from cheap labour countries.

As the majority of manufacturing branches are export-orientated, competitiveness factors are essential for the further development of manufacturing. 76.3% of production of the manufacture of textile and textile products, 74.7% of the manufacture of transport equipment, 71.2% of the manufacture of machinery and equipment, 65% of the manufacture of wood and wood products and 64% of the manufacture of basic metals and fabricated metal products were exported in 2007.

Substantial productivity growth in manufacturing and in many manufacturing branches in particular, is considered as a positive trend. However, increasing labour costs, especially in 2005 – 2007, have a negative impact on competitiveness. For example, in the manufacture of food products and beverages labour costs grew twice as much as domestic and export prices for production. The impact of increasing labour costs is even more dramatic in the manufacture of textiles and textile products because of high labour-intensity. Because of increasing labour costs, production has decreased in the manufacture of machinery and equipment. The manufacture of basic metals and fabricated metal products, on the other hand, is considered to be highly competitive, where the high increase of export prices has largely compensated the increase of production costs.

3. Methodology and results

The choice of modelling tools and methodologies has been heavily influenced by the statistical information currently available in many countries. In Latvia in particular, the availability of statistical information and the level of sectoral disaggregation of the computed indicators are important factors taken into account by experts and model builders in the various fields.

Nevertheless, the situation in Latvia regarding statistical information endowment and quality has improved, especially regarding input-output statistics. Notable results have been achieved by reforming the I-O department and involving new and perspective specialists etc. For a considerably long time, since 2003 when the input-output tables for 1998 were published, the preparation of input-output tables for 2000, 2001, 2002, 2004, and 2005 was carried-out, but not finished due to various and diverse causes.

According to the plans of the Central Statistical Bureau of Latvia and the EU regulations, the input-output tables for 2004 should be finished by mid- 2008. The current processes at the statistical bureau seem promising and the plans achievable. Some of the issues subject to most procrastination are related to the evaluation of trade and transport margins, while some experts also believe that several service sectors are overestimated, as well as changes in stocks being dissimilar from the conventional level as a result of Latvia's accession to the European Union (in May 2004).

However, the preparation process of input-output tables for 2005 has been delayed due to many factors. But taking into account recent changes and improvements at the statistical bureau, this situation also seems promising and results are foreseeable in the near future.

At the moment, in the Latvian INFORUM model productivity by branches is estimated outside the model due to considerably short time series and radical changes in recent years. Taking into account estimated productivity growth and integrating these values in the model, results have been computed which represent further economic and sectoral development on the basis of integrated assumptions. The applied approach was used to examine the economy's dependence on productivity changes. As in many fields, Latvia converges with the average EU level or, at least, the average Baltic States level of indicators, therefore, such a study gives an insight into potential development trends.

Assumptions regarding the scenario are mainly based on current economic trends. Since the fourth quarter of 2007, a slowdown of economic development has been observed, and hence the included assumptions reflect a slowdown in the next few years too. It is believed that households' final consumption will grow by 6% in 2008, by 5.5% in 2009, and in 2010 and 2012 it will recover, but in the long-term it will gradually decrease to 3% in 2020.

Table 3. Output forecasts and employment forecasts*.

No.	NACE code	Output forecasts				Employment forecasts			
		2007-2010	2011-2015	2016-2020	2007-2020	2007-2010	2011-2015	2016-2020	2007-2020
1	A 01	1.030	1.018	0.998	1.014	0.990	0.979	0.969	0.979
2	A 02	1.070	1.057	1.032	1.052	1.029	1.016	1.002	1.015
3	B 05	1.044	1.007	0.970	1.004	1.004	0.968	0.941	0.968
4	C 10	1.004	1.021	0.982	1.002	0.965	0.982	0.954	0.967
5	C 11- C 14	1.004	1.021	0.982	1.002	0.965	0.982	0.954	0.967
6	D 15	1.043	1.025	1.004	1.023	1.003	0.986	0.975	0.987
7	D 16	0.881	1.068	1.038	1.001	0.847	1.027	1.007	0.965
8	D 17	1.079	1.097	1.066	1.081	1.038	1.055	1.035	1.043
9	D 18	1.049	1.073	1.047	1.057	1.009	1.031	1.016	1.019
10	D 19	1.074	1.097	1.056	1.076	1.033	1.055	1.025	1.038
11	D 20	1.065	1.053	1.035	1.050	1.024	1.013	1.005	1.013
12	D 21	1.002	1.060	1.036	1.034	0.963	1.019	1.006	0.998
13	D 22	1.046	1.083	1.054	1.062	1.005	1.042	1.023	1.025
14	D 23	1.043	1.032	1.018	1.030	1.003	0.993	0.989	0.994
15	D 24	1.045	1.043	1.029	1.038	1.005	1.003	0.999	1.002
16	D 25	1.034	1.034	1.019	1.029	0.994	0.995	0.989	0.993
17	D 26	1.086	1.063	1.042	1.062	1.044	1.022	1.012	1.025
18	D 27	1.081	1.064	1.043	1.061	1.039	1.023	1.013	1.024
19	D 28	1.064	1.054	1.035	1.050	1.023	1.013	1.005	1.013
20	D 29	1.096	1.074	1.048	1.071	1.053	1.032	1.018	1.033
21	D 30	1.111	1.070	1.044	1.072	1.069	1.029	1.014	1.035
22	D 31	1.044	1.063	1.041	1.049	1.004	1.022	1.010	1.013

23	D 32	1.052	1.070	1.042	1.055	1.011	1.028	1.012	1.018
24	D 33	1.073	1.058	1.037	1.055	1.031	1.017	1.007	1.018
25	D 34	1.391	1.196	1.123	1.221	1.338	1.150	1.091	1.178
26	D 35	1.110	1.064	1.040	1.068	1.067	1.023	1.009	1.031
27	D 36	1.089	1.070	1.047	1.067	1.047	1.029	1.017	1.030
28	D 37	1.068	1.056	1.037	1.053	1.027	1.015	1.007	1.016
29	E 40	1.027	1.030	1.017	1.024	0.988	0.990	0.987	0.988
30	E 41	1.001	1.022	0.989	1.004	0.963	0.982	0.960	0.969
31	F 45	1.105	1.073	1.051	1.074	1.063	1.032	1.020	1.037
32	G 50	1.047	1.037	1.019	1.033	1.007	0.997	0.989	0.997
33	G 51	1.035	1.031	1.021	1.029	0.995	0.992	0.991	0.992
34	G 52	1.012	1.021	1.016	1.017	0.973	0.982	0.986	0.981
35	H 55	1.047	1.032	1.015	1.030	1.007	0.992	0.986	0.994
36	I 60	1.046	1.037	1.025	1.035	1.006	0.997	0.995	0.999
37	I 61	1.280	1.143	1.089	1.160	1.230	1.099	1.057	1.119
38	I 62	1.071	1.046	1.027	1.046	1.029	1.006	0.997	1.009
39	I 63	1.022	1.029	1.023	1.025	0.983	0.990	0.993	0.989
40	I 64	1.009	1.046	1.032	1.030	0.970	1.006	1.002	0.994
41	J 65	1.039	1.041	1.028	1.036	0.999	1.001	0.998	0.999
42	J 66	1.060	1.051	1.034	1.048	1.020	1.011	1.004	1.011
43	J 67	1.052	1.041	1.028	1.040	1.012	1.001	0.998	1.003
44	K 70	1.019	1.023	1.015	1.019	0.980	0.984	0.985	0.983
45	K 71	1.044	1.043	1.022	1.036	1.004	1.003	0.993	0.999
46	K 72	1.057	1.049	1.033	1.045	1.017	1.008	1.003	1.009
47	K 73	1.066	1.050	1.038	1.050	1.025	1.009	1.007	1.013
48	K 74	1.049	1.044	1.030	1.041	1.008	1.004	1.000	1.004
49	L 75	1.030	1.030	1.029	1.030	0.991	0.990	0.999	0.994
50	M 80	1.036	1.032	1.030	1.032	0.997	0.992	1.000	0.996
51	N 85	1.037	1.038	1.032	1.035	0.997	0.998	1.002	0.999
52	O 90	1.003	1.016	0.996	1.005	0.964	0.977	0.967	0.970
53	O 91	1.111	1.073	1.049	1.075	1.068	1.031	1.018	1.037
54	O 92	1.005	1.016	1.004	1.009	0.967	0.977	0.975	0.973
55	O 93	1.043	1.044	1.031	1.039	1.003	1.003	1.001	1.002

* growth indexes (level of previous period=1).

Table 3 shows the modelling results of average annual growth indexes of output and employment by branches in the given time period. All the branches of the economy are shown, not only the manufacturing sector, to represent the diverse developments within the economy.

On the basis of productivity changes and forecast output, employment by branches was computed within the model. The comparison of forecast employment and labour resources (according to the demographical indicators estimated) in the long-term indicates whether there will be a deficit or surplus of the labour force and therefore, whether the economy demands a re-assessment of the current demographical and immigration policies in the country.

There have been discussions in Latvia, regarding the need for low-cost construction sector workers and some less-skilled manufacturing and service workers from a number of EU countries (Bulgaria, Romania, Poland) or other countries (Moldova, Belarus, etc.) and the consequences of such labour force immigration. The comparison of employment forecasts and estimated labour force (using the Latvian macroeconomic model) indicates that due to the slowdown in economic growth and gradual, but not radical, productivity increase in the long-term, the economy can function without a notable immigration of labour force. However, the model illustrates overall results, and as there are different requirements of skills, education, experience (also taking into account intersectoral labour force migration) in each branch, more sophisticated sectoral models or studies should be carried out.

Conclusions

Despite the recent trend of a gradual decrease of its share in the economy, manufacturing has maintained its position as one of the key sectors and components that cannot be omitted or underestimated.

According to the output and employment results, in many branches the number of employees has decreased, while output continues to grow. This is due to a productivity increase and convergence with the level of the neighbouring EU countries and the forecast population decrease in the long-term in Latvia. Manufacturing, and other sectors too take into account that the total population, as local consumers and labour force, is decreasing and the same trend is observable in many EU countries.

The modelling results presented in the paper illustrate economic growth according to the low economic development scenario assumptions, which were constructed taking into account the recent overall economic situation in Latvia.

References

Auzina A. (2007). INFORUM model development in Latvia: problems and solutions. In M. Plitch, M. Przybylinski (eds.): *Recent Develop-*

ment in INFORUM-type Modelling, Lodz: Lodz University Press, pp. 7-16.

Auziņa A., Počs R. (2007). Latvian multisectoral macroeconomic model. 4th Nordic Econometric meeting konferences materiālos. Tartu: University of Tartu.

Bronisz U., Heijman W., Miszczuk A. (2008). Regional competitiveness in Poland: Creating an index. *Jahrbuch für Regionalwissenschaft*, Accepted: 24 June.

Database of the Central Statistical Bureau of the Republic of Latvia. – <http://data.csb.gov.lv/>.

Drescher K., Maurer O. (1999).Competitiveness in the European Dairy Industries. *Agribusiness*, Vol. 15, 2, Spring, pp. 163-177.

Elgazar H. (2002). Sources of Japanese competitiveness and growth. *International Advances in Economic Research*, Vol. 8, n. 1, February, pp. 65-78.

Eurostat database. <http://epp.eurostat.ec.europa.eu>.

Fisher Ch., Schornberg S. (2007) Determinants of sectoral competitiveness and implications for the EU food&drinks manufacturing industries. *Food Economics*. Vol. 4, n. 3, pp. 148-158. <http://www.ifama.org/tamu/iama/conferences/2007Conference/SymposiumPapers_files/1071_Paper.pdf>.

Fisher Ch., Schornberg S. (2006). The competitiveness situation of the EU meat processing and beverage manufacturing sectors. Paper prepared for presentation at the 98th EAAE Seminar 'Marketing Dynamics within the Global Trading System: New Perspectives', Chania, Crete, Greece as in: 29 June-2 July. <http://ageconsearch.umn.edu/bitstream/10028/1/sp06fi01.pdf>.

Grilo I., Koopman G.J. (2006). Productivity and Microeconomic Reforms: Strengthening EU Competitiveness. *Journal of Industry, Competition and Trade*, Vol. 6, n. 2, June, pp. 67-84.

IMD Word Competiveness Yearbook (2008). <http://www.imd.ch/research/publications/wcy/World-Competitiveness-Yearbook-2008-Results.cfm>.

Kasalis E., Eglīte S., Skujeniece I. (2004) Tautsaimniecības nozaru attīstības tendences, konkurētspēja un struktūra. Research project of Ministry of Economics of Latvia, Riga.

Ketels Ch.H.M. (2006). Michael Porter's Competitiveness Framework—Recent Learnings and New Research Priorities. *Journal of Industry, Competition and Trade*, Vol. 6, n. 2, June, pp. 115-136.

Koehler-Toeglhofer W., Magerl Ch., Mooslechner P. (2006). Revised and New Competitiveness Indicators for Austria Reflect Improvement Trend since EMU Accession. *Monetary Policy and the Economy*, 4 January 2007, pp. 70-97, <http://ideas.repec.org/a/onb/oenbmp/y2006i4b5.html>.

Ķīlis R. (2008). Latvijas ilgspējīgas attīstības stratēģija līdz 2030. Gadam. *Ziņojums ekonomika: konkurētspēja un resursi*, Janvāris, <http://www.chamber.lv/uploads/filedir/File/Ek_konkuretsp_zinojums_final.pdf>.

Ozoliņa V., Počs R. (2006) Forecasting of Latvian Population And Employment (Using Econometric Models). (in Latvian) Scientific Proceedings of Riga Technical University. Series 3. Volume 13. "Economics and Business. Economy: Theory and Practice", Riga, RTU, pp. 87-97.

Ozolina V., Pocs R. (2007). Short- and Longterm Forecasting of Population in Latvian Macro- and Multisectoral Models. Recent Developments in INFORUM-type Modeling. Lodz: Wydawnictwo Uniwersytetu Lodzkiego, pp. 129-139.

Pohl R. (1997). Wages, exchange rates and competitiveness. *Economic Bulletin*, Vol. 34, n. 8 , August, pp. 27-32.

Porter M.E. (1990). *The Competitive Advantage of Nations*. Free: New York.

Report on the Economic Development of Latvia. Ministry of Economics, July 2008.

Sirikrai S.B., Tang J.C.S. (2006). Industrial competitiveness analysis: Using the analytic hierarchy process. *The Journal of High Technology Management Research*, Vol. 17, 1, 2006, pp. 71-83. <http://tinyurl.com/kook6s/>

The Global Competitiveness Report 2008-2009. <http://www.weforum.org/en/initiatives/gcp/Global%20Competitiveness%20Report/index.htm>.

The UK 2007 productivity & competitiveness indicators. URN: 08/P39. Department for Business, Enterprise & Regulatory Reform's. <http://www.berr.gov.uk/files/file43540.pdf>.

Vanags A., Leduskrasta Z. (2005). Latvijas konkurētspēja un tās izvērtējums starptautiskos reitingos. Research project for Ministry of Economics of Latvia. Baltic International centre for economic policy studies, Riga.

Vanags I. *et al.* (2004). Rūpniecības nozaru konkurētspējas pētījumu struktūras pamatprincipi. EM Nr. 2004/119. Research project of Ministry of Economics of Latvia, Riga.

AN ANALYSIS OF SECTORAL STRUCTURE: ESTONIA IN THE CONTEXT OF THE EU ECONOMIES

Tiiu Paas, Jüri Sepp
University of Tartu

1. *Introduction*

The paper aims to offer some empirical insights into structural change in the EU countries over the last decade, the period characterising the extension of the EU eastwards. The focus of the study is on a comparative analysis of the Estonian economic structure within the EU. Estonia, and the two other Baltic States, Latvia and Lithuania, are the only former Soviet Republics which are members of the enlarged EU. Their favourable location between the East and West, experience of the market economy gained during the period of independence between the two world wars, and historical and cultural traditions of co-operation with developed countries around the Baltic Sea were important initial conditions affecting the economic development of these states during the post-socialist transition and EU integration. These countries therefore provide an interesting case for generalizing the post-socialist transition and European (re)integration processes in the global context too. Hopefully, Estonia also provides an interesting case for future analysis of how a small economy with post-socialist path-dependence responds to a global economic crisis and adjusts to the new challenges posed by globalization.

Sectoral change is an important feature of modern market economies which supports economic development and enables adjustment to the requirements of globalisation. Consequently, the analysis of economic structures and their dynamics which started back in the first half of the 20th century (see Firsher 1935, Clark 1940; Fourastié 1949) is a research topic which continuously attracts researchers from different parts of the world. Sectoral shifts and their effects on productivity have been analysed from different angles and using various methodological approaches (e.g. Baumol 1967; Peneder 2002; Havlik 2004 and 2007; Burda 2006; Breitenfellner and Hildebrandt, 2006, Bachmann and Burda 2008). Research results mainly confirm that processes of tertiarization (the movement towards a service-based economic structure) are spreading around

Maurizio Grassini and Rossella Bardazzi (edited by), *Energy Policy and International Competitiveness*,
ISBN 978-88-6453-040-6 (print) ISBN 978-88-6453-043-7 (online)

the world. These developments are associated with the changes in shares of sectors by creating value added as well as the movement of labour between sectors inducing new challenges for the development of human capital and the education system. Some structural change is short run – reflecting temporary shifts in technological and innovative development, while the rest is are more or less permanent.

The initial research results of structural change in the EU countries since the expansion eastwards have shown the EU's new member states (NMS) catching-up on productivity in an impressive manner, at a macroeconomic level and in the manufacturing industry in particular, but these sectoral shifts have a negligible effect on aggregate productivity growth (see Havlik, 2007, p. 10). Economies with different sectoral structures have essentially different opportunities of growth. Therefore it is obvious that a profound analysis of sectoral change is essential to elaborate models of the best ways for national economies to adjust to global and regional developments.

Analyses based on Eurostat sectoral data for the EU-27 economies were examined using a combination of several statistical methods in order to elaborate aggregate indicators (latent variables) of the EU economies' sectoral structure and explore the relationship between the aggregate indicators of economic structure and productivity. The data used for the analysis describe the sectoral structure of value added in the EU27 member states in six economic sectors for the years 1995–2005.

This paper consists of four sections. The next section gives a short overview of the sectoral structure of the EU economies. Section 3 presents the results of elaboration and analysis of the aggregate indicators describing sectoral structures and examines the relationship between productivity and sectoral structure. The case of Estonia is considered in the context of the EU-27 economies. Section 4 contains the conclusions.

2. *Main shifts in the sectoral structure of the EU economies*

The main shifts in sectoral structure can be identified as follows:

1. the shift from an agricultural to an industrial economy, which began in England and has extended to most western countries (the process of industrialization);
2. the shift from an industrial to a service economy which started in the United States and is evident in all developed economies (the process of tertiarization).

These shifts in sectoral structure have been extensively analysed in literature on the changing economic structure of highly industrialized economies, concluding that the expansion of the service industry may be the result of: a) a shift in the structure of final demand from goods to services; b) changes in the inter-industry division of labour, favouring the emerging of specialized service activities; and c) inter-industry productivity differentials. (e.g. overview Schettkat and Yocarini, 2003).

The shift to the service sector does not always result from a change in final demand, but also from differential productivity growth (see Baumol 1967 and 2001). Since service sector productivity increases less than manufacturing productivity, the share of employment in the service sector will be higher in high-income economies. If wages in the service sector increase in line with an economy's average rate of wage increase , then the share of services in nominal output will also rise with income. Such an increase does not always reflect a greater desire for services, but may also indicate that the level of technology implemented in the service sector is often lower than in manufacturing.

The shift in the sectoral structure of an economy can be analysed on the basis of a wide range of indicators (employment, added value, GDP, etc.) and at different levels of economic sectors. In this paper the sectoral structure of the EU economies based on the share of added value in GDP of the six aggregated economic sectors was analysed. Table 1 presents the 6-level classification system of economic sectors used in the Eurostat database.

Table 1. Classification of economic sectors.

Economic sectors	Aggregated sectors	Classification code in the Eurostat database
Agriculture, hunting, forestry, fishing	**S1** (Agriculture**)**	A-B
Manufacturing (except contruction)	**S2** (Manufacturing)	C-E
Construction	**S3 (**Construction**)**	F
Wholesale and retail trade; repair of motor vehiles and household appliances, hotels and restaurants, transport, warehousing, communication	**S4 (**Trade)	G-I
Financial mediation, real estate, renting and business activities	**S5 (**Financial) service)	J-K
Public administration and civil defence; compulsory social insurance, education, health care and social welfare, etc.	**S6 (**Public service)	L-P

Source: Eurostat

Sectoral shifts in employment and in GVA structure explain the extension of the process of tertiarization in the EU economies. According to ILO data, the service sector's share of total employment grew from 66.1% in 1995 to 71.4% in 2005 while the industry sector shrank from 28.7% to 24.9% over the same period (ILO 2006).

The main trends in the sectoral change of the EU-27 economies can be described by the decline of the shares of the agriculture and manufacturing sectors and the increase of the share of the service sector (see Annex 1, Figg. F1-F6). The industrialized countries of the EU have already entered the stage of post-industrialised service economies. There is also a remarkable variation in these shifts between the EU economies, particularly when comparing economic structures in the old EU (EU-15) and new member states (NMS, EU-12). It may be concluded that by the mid-2000-s the economic structure of the so-called «old» members of the EU (except for Spain and Greece) had become relatively similar.

Andreas Breitenfeller and Antje Hildenbrandt (2006) analysed the development of the sectoral structure of the EU-15 economies over the period 1950-1998 and distinguished four groups of countries according to models of tertiarization. These models adequately describe the variation in the economic structure of the EU economies before the EU enlargement process eastwards started. The first group of countries (Belgium, France, Ireland, Netherlands and the UK) pursued a model of dynamic tertiarization, characterized by the accelerated development of market services. Demand for consumption-related services was stimulated by a strong focus on the domestic economy as well as by trade specialization in service export. Structural shifts were supported by liberalization and deregulation. The second group of countries (Germany, Italy, Austria) pursued a model of lagging tertiarization characterized by a comparatively stable position of the manufacturing sector in an economic structure. The assumption for introducing this approach was the view that productivity growth can be generated primarily in the industry sector. Another reason for lagging tertiarization was the corporatist system of social partnership, giving higher priority to the competitiveness of industrial locations than to national policies. The Nordic countries (Denmark, Finland, Sweden) pursued a model of managed tertiarization embodying a strategy promoting the development of knowledge-based and social services supported by the promotion of human capital development and innovation. The fourth group of countries (Greece, Spain and Portugal) pursued a model of catching-up tertiarization. This model reflects the general shift toward the service sectors associated with rising per capita income mainly due to EU accession.

The shifts to service-based economies occurring in Central and Eastern Europe were much faster than in the EU-15. The NMS have some similarities with Southern European countries in the development of their economic structure and pursuit of the tertiarization processes. Evidently the NMS do not need to pursue the same development pattern that the countries previously trying to catch-up with tertiarization had to. The global environment for competitive development is changing quickly and adjustment to the rapid changes requires flexible product structures and factor markets as well as the promotion of innovation diffusion and creation of human capital.

Estonia's transition to a market economy and sectoral shifts to tertiarization have been enhanced by integration with the EU. In the 1970s and 1980s Estonia had the typical features of an industrial country. At the end of 1980s the share of manufacturing and agriculture was larger than in developed countries while the share of service sectors was modest. However the structure and dynamics of the Estonian economy have been substantially influenced by local natural resources, of which oil shale is the most important. This industry produces most of the electricity in Estonia. Substantial investments were made in the 1980s in transportation, of which the most important construction was Muuga Port near Tallinn. This port has been increasingly important for the Estonian economy, serving domestic needs as well as transit trade after regaining independence (see Lumiste *et al.*, 2008). The transition of Estonia to a market economy was also accompanied by the introduction of modern banking and finance, real estate markets, and business services ((see Annex 1, Figg. F1-F6). The retail and wholesale trade also grew very rapidly. We can consider Estonia as an example of an open economy in which economic growth and sectoral change are largely based on foreign trade and FDI, on the rapid development of construction and unfortunately, also on the recent real estate boom.

3. Aggregated indicators of sectoral structure as factors explaining the variability of countries' productivity levels

3.1. Aggregated indicators of sectoral structure

In order to get a more in-depth view of the sectoral structure of the EU-27 economies, several statistical methods were applied in the paper. Firstly, the relationships between the initial sectoral indicators of the countries' economic structures were assessed by a correlation analysis. Then, by using factor analysis (method of principal components) the aggregated indicators characterising the economic structures of the EU-27 economies were elaborated. We estimated a factor model based both on the cross-section data of the years 1995, 2000 and 2005 and on the pooled data (27 countries and 6 years, 2000-2005) checking for solidity of the results too. In order to study the relationship between the aggregated indicators of sectoral structure and productivity, several regression models were estimated. These models enabled us to evaluate the differences between actual productivity and so-called potential productivity – the productivity calculated on the basis of the aggregated characteristics of a sectoral structure also taking into account the size and path-dependence of the economies.

The aggregated indicators (latent variables) for describing the economic structure of the EU27 countries were obtained using factor analysis. In all cases two aggregated indicators of an economic structure were extracted – factors F1 and F2. These two factors describe around two-thirds of the variance of the initial indicators of sectoral structure (a sector's GVA share of GDP). A factor matrix based on cross-sectional data is presented in Annex 2. The components of a factor matrix – factor loads describe the correlations between the initial (measured) indicators (shares of sectors S1-S6' GVA in GDP) and factors – latent variables, the aggregated indicators of a sectoral structure.

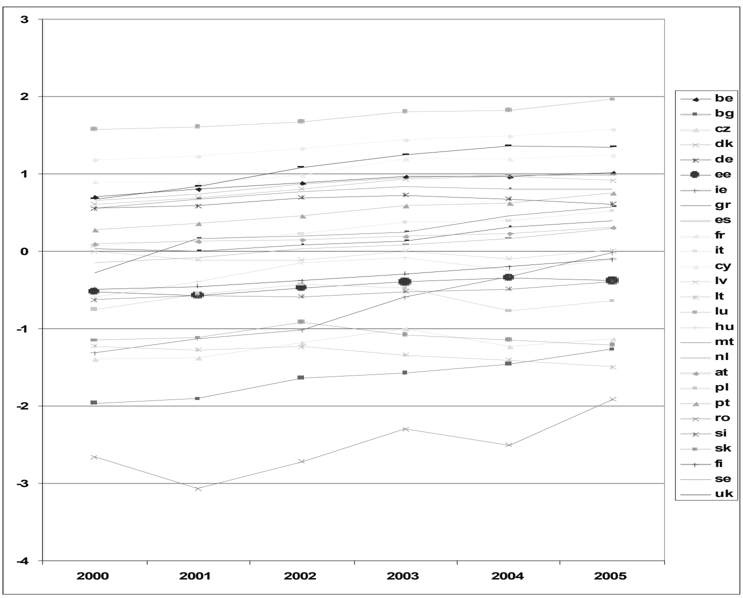
The most challenging part of implementing factor analysis is the economic interpretation of the statistical results. The first step in this work was the analysis of the factor loads in order to explore the economic meaning of the latent variables (factors), giving them respective names. The next step of the analysis focused on the factor scores which describe the value of the aggregated indicators of each observation. Factor scores are standardised.

Factor F1 has higher negative factor loads for initial indicators describing sectors S1 (agriculture, forestry) and S2 (manufacturing), and higher positive factor loads for sectors S5 (financial service, etc) and S6 (public sector services). Based on these indicators we decided to call F1 the factor describing the development level of a post-industrial service economy. In the case of factor F2, the largest negative factor loads detected regarded sectors S3 and S4 (construction and trade-tourism-transport), while the largest positive factor loads were observed for S2. We supposed that manufacturing as an economic sector can be considered a necessary prerequisite for broad-based technological innovation. Most service areas (sectors S3 and S4) were relatively passive in terms of technological innovation – they are recipients rather than providers of innovation spillovers. Thus we decided to interpret factor F2 as the factor describing the environment for technological innovation.

The levels of the aggregated indicators of the EU-27 countries' sectoral structure, factors F1 (development level of a post-industrial service economy) and F2 (environment for technological innovation) are characterised by the factor scores of these factors. Figures 1 and 2 respectively illustrate the level and dynamics of the aggregated indicators of economic structure (factors F1 and F2) of the EU-27 counties during the period 1995-2005 (see also Annex 3).

The aggregated indicator characterising the development level of the post-industrial service economy (F1) is normally low in all the Central and Eastern European countries which acceded to the EU in 2004 (the EU-8; Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia) and later (Bulgaria and Romania). Based on the level of the indicators describing the environment of technological innovation (F2), Southern Europe and the Baltic countries differ considerably from the average European indicator, being much lower. However, this is not always the case for some Central European countries such as Hungary, Czech Republic and Slovenia.

Figure 1. Factor scores of Factor 1 – the development level of post-industrial service economy in the EU-27 countries, 2000-2005. Source*:* author's estimations based on the Eurostat data.

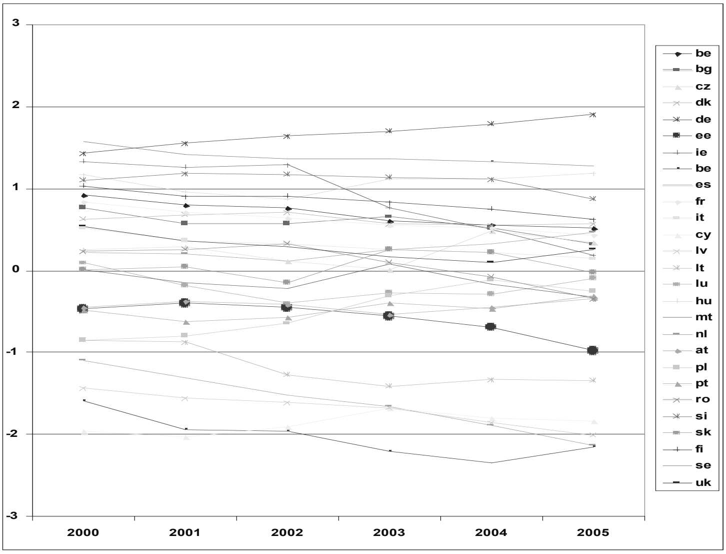


On the basis of the level of the aggregated indicators and dynamics of the respective factor scores of the latent variables – factors F1 and F2 (see also Annexes 3 and 4) three groups of countries can be distinguished within the EU-27:

1. Western and Northern European welfare countries with a developed service economy (Belgium, Sweden, Denmark, Germany, etc);
2. Southern European countries where tourism has a strong position in the economic structure (Portugal, Greece, Spain);

3. Eastern and Central European countries, where the manufacturing sector still retains a relatively big share, albeit gradually declining in favour of the service sectors (the Baltic States, Poland, Slovakia, etc).

Figure 2. Factor scores of Factor 2 – the environment for technological innovation in the EU-27 countries, 2000-2005. Source: author's estimations based on the Eurostat data.



The first group of countries is made up of Western and Northern European countries with developed service economies, characterized by the relatively high factor scores of factor F1. In these countries (particularly in Germany and Sweden) manufacturing maintains a strong position in creating added value. Thus in this respect, they are clearly distinct from the second group of countries, consisting mainly of Southern European economies in which the share of sector S4 is significant in creating GVA. In general the first two groups of countries represent the EU-15 countries indicating the possible paths of development for the new EU member states. The latter are facing the problem of how to overcome the de-industrialization phase and move from the low value added sectors to the high value-added with as little damage as possible. The third group of countries is made up of transition countries with low factor scores for F1. Taking into account the level and dynamics of factor scores for F2 this group of countries is not homogeneous. After their recent development, characterized particularly by the construction boom, the Baltic states are coming closer to the countries of Southern Europe. Hungary and Slovenia are in some sense closer to Finland and Ireland. Of course, we should treat these results with caution, taking into account that the economies under observation are at different stages of development as well in different business cycles.

The sectoral structure of Estonia's economy has been experiencing the trends of declining factor scores of both factors F1 and F2, although the declining trend has been significantly notably slower for F1 than for F2. The Estonian economic structure is characterized by a low level of manufacturing-based technological innovation. In countries with a well developed manufacturing sector, the technological innovations created in this sector are gradually transferred to other economic sectors, thus creating additional opportunities for technological innovation and also for developing and offering new services. It is difficult to build up a modern and internationally competitive service sector without passing the interim stage of more complex industry (see also Hirsch-Kreinsen et al, 2005). Thus, it can not be predicted that Estonia's economic future will follow the path of Luxembourg (i.e., developing strong modern service sectors including financial services). Estonia's current economic structure suggests that its development will be closer to that of the countries of Southern Europe. In other words, the structure of the Estonian economy is becoming more similar to that of Greece than to that of Luxembourg. Of course, Estonia is not the only exception among the NMS. The situation and trends described are also predicted for the two other Baltic states as well the majority of the NMS.

3.2. The relationship between aggregated productivity and sectoral structure

In order to study the relationship between the sectoral structure and aggregated productivity of the EU-27 economies, we estimated regression models based on Eurostat productivity data and the aggregated indicators (factor scores of factors F1 and F2) of sectoral structure of the EU-27 economies.

The basic regression equation for exploring the relationship between the productivity indicators and the sectoral structure of an economy is as follows:

$$(1)\quad Y_{it} = \alpha + \sum_{j=1}^{k} \beta_j X_{jit} + \sum_{j=k+1}^{k'} \beta_j D_{ji} + u_{it}$$

where

Y_{it} – aggregated productivity in the country *i* at time *t* (added value per employee in euros; in year 2000 prices);

X_{jit} – explanatory variable characterizing the sectoral structure of the country *i* at time *t,* factor scores of the aggregated factors F1 and F2;

D_{ji} – dummy variables, proxies that characterize path-dependence and the size of an economy; D_{1i} = 1 if country i is a NMS and D_{1i} = 0 otherwise;
D_{2i} =1, if a small country (the population is 6 million or less), D_{2i} = 0 otherwise;
α – intercept;
β_j – parameters of the explanatory variables;
j = 0, 1, 2, … k and k';
n = sample size.

The estimated regression models describe approximately 64-87% of the variability of aggregated productivity in EU-27 countries (Table 2).

Table 2. Regression models for estimating aggregated productivity in the EU-27 countries.

Intercept	F1	F2	D1	D2	R^2	
34882.2	16424.0	6848.3			0.644	0.640
(1084.730)	(1070.259)	(1068.444)	–	–		
(0.000)	(0.000)	(0.000)			(0.000)	(0.000)
44942.179	6739.633	4276.095	-31156.129	7926.625	0.871	0.868
(1058.508)	(880.855)	(675.225)	(1910.254)	(1433.306)		
(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Dependent variable: aggregated productivity measured as added value per employee in euros (in year 2000 prices); n= 162.

The estimators show that both the development level of the post-industrial economy (F1) as well as the environment for technological innovations (F2) is related to productivity in the same direction. The productivity of new member states is below-average. Thus, we argue that the hypothesis of a post-socialist path-dependence was confirmed. The estimation results also confirmed the validity of the hypothesis that the productivity of small countries in the EU-27 is somewhat higher than average. Evidently, knowledge spillovers are sometimes quicker in small countries, inducing innovations and creating conditions for productivity growth.

Path-dependency at a sectoral level is often expressed by technological trajectories and knowledge which are cumulative and build upon earlier technology and learning abilities. The firms of the new EU member states are generally much more constrained by their environment than firms in the highly developed countries. The firms of the NMS may have the ability to introduce a new product or process, but this possibility depends strongly on the skills of entrepreneurs and workers in that country; there is also often a lack of substantial investments.

These evaluation results could be considered as the so-called potential productivity – the productivity level that the given country could have achieved if it had been influenced by sectoral structure characterized by aggregated indicators - factors F1 and F2 also taking into account the size and path-dependence of an economy. In order to compare predicted productivity (the so-called «potential» productivity) with real productivity standardized residuals were calculated (see Annex 5).

A comparable assessment of the so-called potential productivity of the EU27 economies shows that the real productivity of the Estonian economy is considerably lower than the estimated level. Taking into consideration the results of our analysis one may conclude that Estonia's economic structure and sectoral change mainly fit the model of catching–up tertiarization described by Andres Breitenfeller and Antje Hildebrandt (2006). This model generally summarizes the developments in sectoral structure experienced by countries which joined the EU at a later stage: during the southern enlargement round (such as Greece, Spain and Portugal) or during the eastern enlargement round (as in the case of the post-socialist countries). The low-labour oriented foreign direct investment contributed significantly to sectoral shifts in Estonia and still has an impact on the sectoral structure of the economy.

4. *Conclusions*

The most important common trend in recent economic development has been a shift of sectoral structure towards service activities, the process of tertiarization. Sectoral change is a natural process that occurs in all countries, being related to global and national business cycles. The EU enlargement and globalization processes posed new challenges for sectoral change, particularly for the new EU member states like Estonia. Therefore the NMS should analyse previous lessons in depth and look for the advanced tertiarization paths which would be best for their development. We therefore estimated factor models for exploring the sectoral structure of the EU27 economies using both cross-section and pooled data, checking for the solidity of the results. In all cases, two aggregated indicators (latent variables) – factors of an economic structure were extracted. Factor F1 characterised the level of development of the post-industrial service economy and factor F2 the environment for technological innovation.

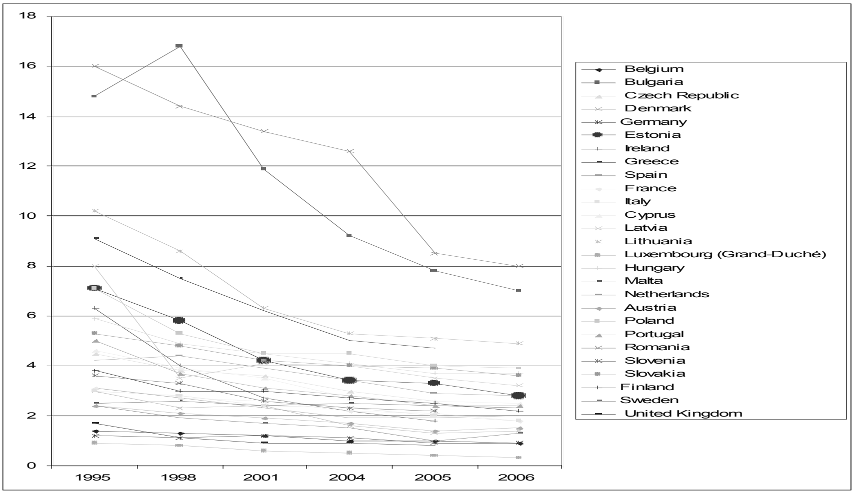
On the basis of the level and dynamics of the aggregated indicators describing the sectoral structure of the EU27 economies in general, three groups of EU countries may be distinguished: 1) Western and Northern European welfare countries with a well-developed service economy as well as manufacturing (Sweden, Denmark, Finland, Germany, etc); 2) Southern European countries where tourism has a strong position in the economic structure (Portugal, Greece, Spain); 3) Eastern and Central European countries, where the manufacturing sector still maintains a relatively big share, which is gradually declining in favour of service sectors (the Baltic States, Poland, Hungary, etc). The first two groups of countries, representing the EU-15 countries, indicate the possible development paths for the new EU member states. Estonia, like other Eastern and Central European post-socialist countries is facing the problem of how to overcome the de-industrialization phase and move from low value added sectors to high value-added sectors with as little damage as possible .

Based on the aggregated indicators of sectoral structure and also taking into account the size and path-dependence of an economy, the regression models exploring aggregated productivity of the EU-27 countries were estimated. The estimators showed that both the development level of the post-industrial economy (F1) as well as the environment for technological innovations (F2) is related to the productivity level in the same direction. Productivity of the new member states is as a rule below-average. We suppose that the hypothesis that the post-socialist path-dependence matters, was confirmed. The estimation results also proved the validity of the hypothesis that the productivity of small countries of the EU-27 is somewhat higher than average. Evidently, knowledge spillovers are sometimes quicker in small countries inducing innovations and creating conditions for productivity growth. Summarising the results of the analysis one should emphasize that the real productivity of the Estonian economy is significantly lower than the estimated level.

Thus, Estonia should place serious emphasis on using its resources and development potential more effectively and overcoming the consequences of the global financial crisis as well as the serious economic decline which started in 2008 with as little damage as possible. The rise in productivity requires planned efforts in modernizing the economic structure while also taking into account the path-dependence and size of an economy. We propose that in the case of Estonia as a catching-up new EU member, the path-dependency should be examined first of all on the level of the whole system of innovation in order to promote the necessary structural change. The process of modernization cannot be achieved without targeted innovation policies, flexible labour markets and systematic investments in human capital. We suppose these are the key factors for conducting successful national policies which support productivity growth.

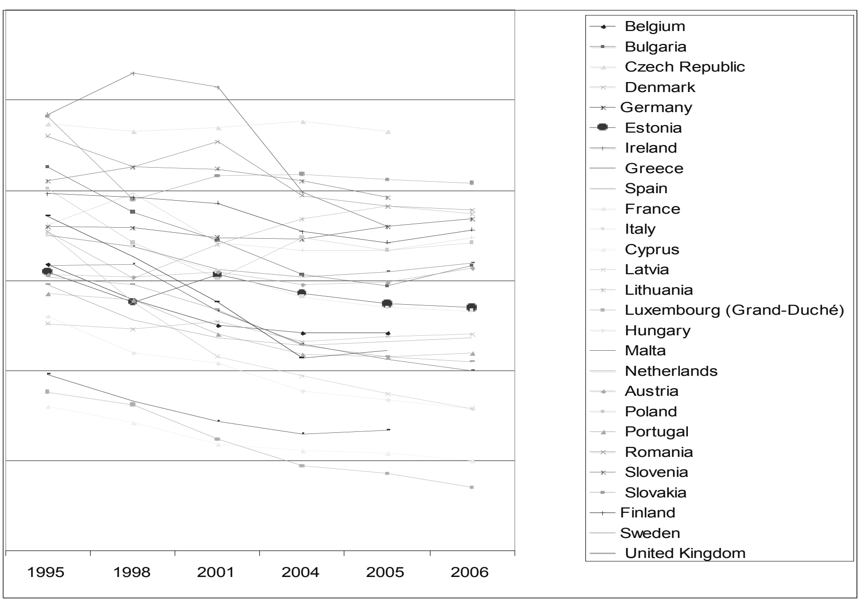
Annex 1. Sectoral changes in the EU-27 countries, 1995-2005 in sectors 1-6 (the share of GVA in GDP, %): figures F1-F6

Figure F1. Dynamics of the share of GVA in GDP, Sector 1.



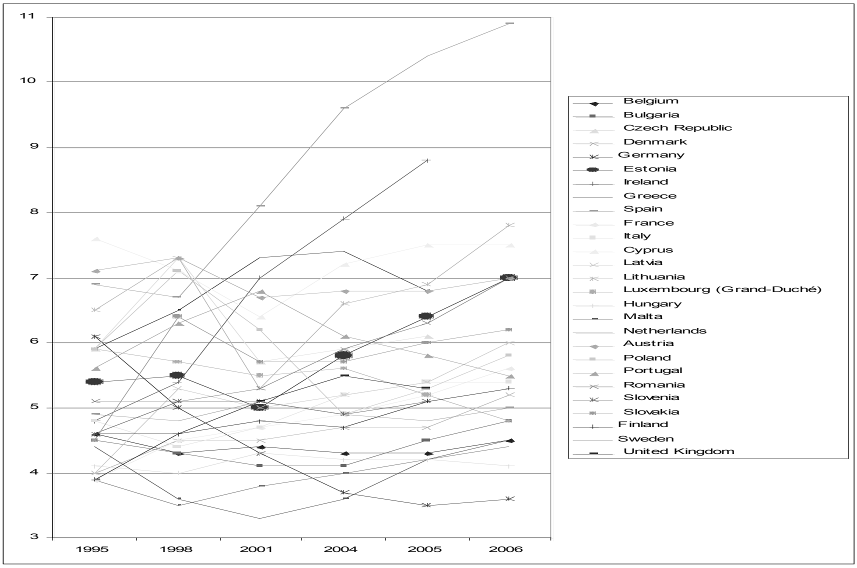
Source: Eurostat.

Figure F2. Dynamics of the share of GVA in GDP, Sector 2.



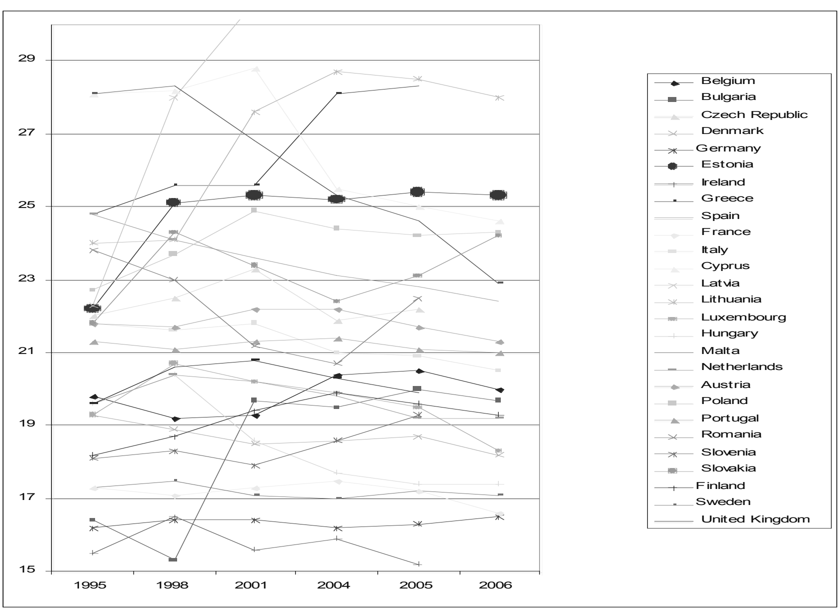
Source: Eurostat.

Figure F3. Dynamics of the share of GVA in GDP, Sector 3.



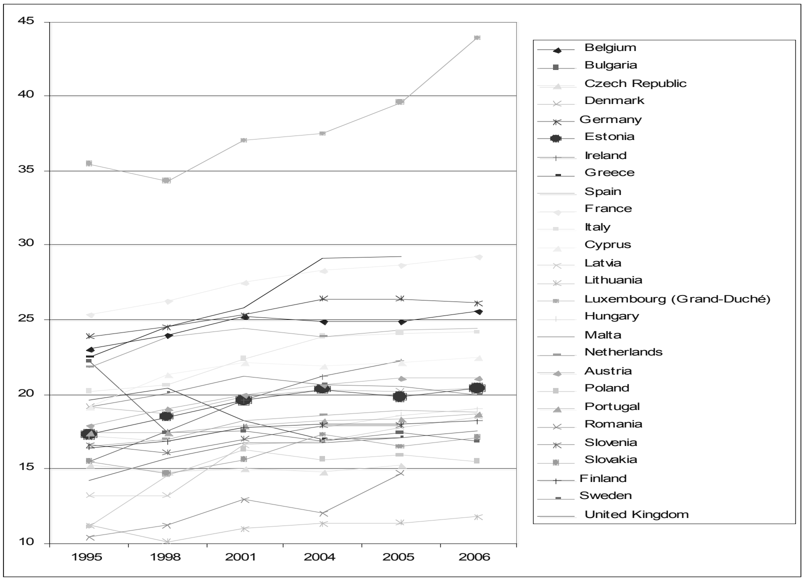
Source: Eurostat.

Figure F4. Dynamics of the share of GVA in GDP, Sector 4.



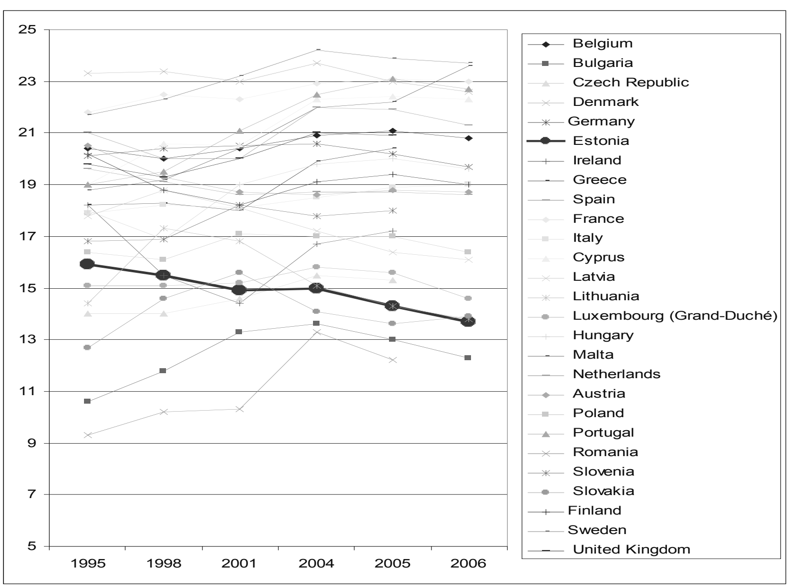
Source: Eurostat.

Figure F5. Dynamics of the share of GVA in GDP, Sector 5.



Source: Eurostat.

Figure F6. Dynamics of the share of GVA in GDP, Sector 6.



Source: Eurostat.

Annex 2

Table T1. Correlation matrix of the initial indicators of the EU-27 economies' sectoral structure (based on the share of value added in GDP), 1995-2005.

	S1	S2	S3	S4	S5	S6
S1	1	.261(**)	.064	.246(**)	–.596(**)	–.599(**)
S2	.261(**)	1	–.102	–.298(**)	–.536(**)	–.473(**)
S3	.064	–.102	1	.285(**)	–.137	–.218(**)
S4	.246(**)	–.298(**)	.285(**)	1	–.411(**)	–.218(**)
S5	–.596(**)	–.536(**)	–.137	–.411(**)	1	.294(**)
S6	–.599(**)	–.473(**)	–.218(**)	–.218(**)	.294(**)	1

* the level of significance 0.05; ** the level of significance 0.01; n=168
Source: calculations based on the Eurosta data

Table T2. The matrix of factor loads describing sectoral structure of EU-27 countries.

Sectors	F1	F2
S1	–.786**	–.211
S2	–.745**	.531**
S3	.096	–.642**
S4	.188	–.858**
S5	.791**	.213
S6	.762**	.127

** – level of significance 0.01
Source: calculations based on the Eurostat data.

Annex 3. Factor scores of the factors 1 and 2 in the EU-27 countries, 2000-2005

Table T3. Factor scores of factor F1 – development level of post-industrial service economy

Country	2000	2001	2002	2003	2004	2005
Belgium	0,71	0,81	0,89	0,96	0,96	1,01
Bulgaria	–1,96	–1,90	–1,63	–1,56	–1,45	–1,26
Czech Republic	–1,39	–1,37	–1,17	–1,00	–1,23	–1,13
Denmark	0,61	0,70	0,81	0,93	0,98	0,92
Germany	0,56	0,59	0,70	0,73	0,68	0,61
Estonia	–0,52	–0,56	–0,47	–0,40	–0,34	–0,38
Ireland	–1,31	–1,12	–1,02	–0,59	–0,32	–0,01
Greece	0,03	0,01	0,09	0,14	0,32	0,39
Spain	–0,15	–0,08	0,03	0,09	0,17	0,30
France	1,19	1,23	1,34	1,44	1,49	1,59
Italy	0,08	0,14	0,23	0,38	0,39	0,52
Cypros	0,91	0,90	0,98	1,19	1,20	1,26
Latvia	0,00	–0,11	–0,10	0,01	–0,09	0,02
Lithuania	–1,22	–1,27	–1,23	–1,34	–1,40	–1,50
Luxemburg	1,59	1,61	1,68	1,81	1,82	1,97
Hungary	–0,58	–0,40	–0,15	–0,09	–0,23	–0,12
Malta	–0,28	0,17	0,20	0,25	0,46	0,58
The Netherlands	0,66	0,74	0,87	0,95	0,99	0,99
Austria	0,10	0,13	0,15	0,20	0,24	0,31
Poland	–0,74	–0,55	–0,43	–0,48	–0,77	–0,64
Portugal	0,28	0,36	0,46	0,59	0,63	0,75
Romania	–2,66	–3,06	–2,71	–2,30	–2,50	–1,91
Slovenia	–0,62	–0,58	–0,58	–0,52	–0,48	–0,39
Slovakia	–1,15	–1,11	–0,91	–1,07	–1,14	–1,20
Finland	–0,49	–0,45	–0,38	–0,29	–0,20	–0,10
Sweden	0,56	0,68	0,77	0,84	0,81	0,81
UK	0,68	0,85	1,09	1,25	1,37	1,35

Source: author's estimations based on the Eurostat data.

Table T4. Factor scores of factor F2 – environment for industry-based technological innovation.

Country	2000	2001	2002	2003	2004	2005
Belgium	0,92	0,80	0,76	0,60	0,56	0,52
Bulgaria	0,77	0,57	0,57	0,66	0,52	0,32
Czech Republic	0,25	0,29	0,12	0,01	0,48	0,34
Denmark	0,63	0,68	0,71	0,57	0,55	0,56
Germany	1,43	1,55	1,64	1,70	1,79	1,90
Estonia	–0,47	–0,40	–0,45	–0,55	–0,69	–0,98
Ireland	1,33	1,26	1,28	0,77	0,50	0,18
Greece	–1,59	–1,94	–1,96	–2,20	–2,35	–2,15
Spain	–1,10	–1,31	–1,52	–1,66	–1,88	–2,13
France	0,84	0,71	0,64	0,55	0,52	0,43
Italy	0,51	0,36	0,32	0,26	0,23	0,14
Cypros	–1,96	–2,04	–1,91	–1,68	–1,81	–1,84
Latvia	–1,44	–1,56	–1,61	–1,68	–1,86	–2,00
Lithuania	–0,85	–0,88	–1,27	–1,41	–1,33	–1,34
Luxemburg	0,09	–0,18	–0,40	–0,27	–0,28	–0,09
Hungary	1,17	0,96	0,88	1,12	1,11	1,18
Malta	0,01	–0,15	–0,23	0,08	–0,17	–0,33
The Netherlands	0,22	0,21	0,11	0,25	0,32	0,47
Austria	–0,45	–0,37	–0,42	–0,54	–0,45	–0,35
Poland	–0,85	–0,79	–0,64	–0,30	–0,11	–0,25
Portugal	–0,48	–0,62	–0,57	–0,39	–0,46	–0,31
Romania	0,23	0,26	0,33	0,10	–0,07	–0,35
Slovenia	1,10	1,18	1,17	1,13	1,11	0,87
Slovakia	0,01	0,05	–0,14	0,26	0,22	–0,02
Finland	1,03	0,90	0,91	0,83	0,75	0,62
Sweden	1,57	1,41	1,36	1,36	1,33	1,27
UK	0,54	0,36	0,29	0,16	0,10	0,26

Source: author's estimations based on the Eurostat data.

Annex 5. Actual and predicted productivity (predicted in EU-27 countries in 2005

Country	Actual	Predicted	Residuals	Standardised residuals[1]
Belgium	67200.00	56342.93432	10857.06568	1.21134
Bulgaria	4400.00	10446.86313	-6046.86313	-.67466
Czech Rep.	12000.00	11489.53243	510.46757	.05695
Denmark	56400.00	55799.42461	600.57539	.06701
Germany	58900.00	58871.95768	28.04232	.00313
Estonia	9200.00	11875.45138	-2675.45138	-.29851
Ireland	56100.00	47288.56488	8811.43512	.98311
Greece	35100.00	41064.53430	-5964.53430	-.66547
Spain	36200.00	40418.17209	-4218.17209	-.47063
France	58400.00	60312.24238	-1912.24238	-.21335
Italy	47700.00	51189.03402	-3489.03402	-.38928
Cyprus	31700.00	20730.50859	10969.49141	1.22389
Latvia	7200.00	10774.75692	-3574.75692	-.39884
Lithuania	6700.00	2066.35760	4633.64240	.51698
Luxembourg	76300.00	61111.13811	15188.86189	1.69465
Hungary	13500.00	22479.79892	-8979.79892	-1.00189
Netherlands	52900.00	55980.99901	-3080.99901	-.34375
Austria	62100.00	47647.84187	14452.15813	1.61245
Poland	13200.00	12834.26463	365.73537	.04081
Portugal	25000.00	51094.66498	-26094.66498	-2.91143
Romania	5100.00	2935.97608	2164.02392	.24144
Slovenia	25500.00	19199.61557	6300.38443	.70295
Slovakia	10700.00	9515.91125	1184.08875	.13211
Finland	58700.00	48423.85564	10276.14436	1.14653
Sweden	53700.00	57790.69292	-4090.69292	-.45641
UK	43400.00	57845.70085	-14445.70085	-1.61173

Source: author's estimations based on the Eurostat data.

[1] Standardized residuals $\hat{u}_i^* = \frac{Y_i - \hat{Y}_i(i)}{\hat{\sigma}(i)}$, $\hat{\sigma}^2(i) = \sum_{j=1}^{n} \hat{u}_j^2(i) / (n-k)$,

k – the number explanatory variables, n – sample size. If $|\hat{u}_i^*| > 1.96$, then the observation could be considered as an exceptional.

References

Bachmann R, Burda, M. (2008). Sectoral Transformation, Turbulence and Labor Market Dynamics in Germany. *IZA Discussion Paper* N03324/2008, January.

Baumol W.J. (1967). Marcoeconomics of Unbalanced Growth: the Anatomy of Urban Crisis. *American Economic Review*, 57, pp. 415-426.

Baumol W.J. (2001). Paradox of the Services: Exploding Costs, Persistent Demand. Ten Raa, T., Schettkat, R. (eds.) *The Growth of Service Industries: The Paradox of Exploding Costs and Persistent Demand*. Cheltenham: Edward Elgar. pp. 3-28.

Breitenfellner A., Hildenbrandt A. (2006). High Employment with Low Productivity? The Service Sectos as a Determinant of Economic Development. *Monetary Policy and Economy*, Q1 /06, pp. 110-135.

Burda M. (2006). Factor Reallocation in Eastern Germany after Reunification. *American Economic Review*, 96, 2006, pp. 368-374.

Burda M. (2007). What kind of shock was it? Regional Integration and Structural Change in Germany after Unification. Kiel Working Paper N0 1306.

Clark C. (1940). *The conditions of economic progress*. London.: Macmillan.

Fisher A.G (1935). *The clash of progress and security*. London.: Macmillan.

Havlik P. (2004). Structural change, productivity and employment in the new EU Member States. – EU DG Employment Research Project Papers. The Vienna Institute for International Economic Studies.

Havlik P. (2007). Economic restructuring in the New EU Member States and Selected Newly Independent States: the Effects on Growth, Employment and Productivity. INDEUNIS Papers, Workshop No12/2007, The Vienna Institute for International Economic Studies, pp. 10-45.

Hirsch-Kreinsen Jacobsen D.. Laestadius S. (2005). Low-tech innovation in der knowldge economy. Peter Lang, Frankfurt.

ILO (2006). Global Emplyment Trends Brief.

Lumiste R., Pefferly R., Purju A. (2008). Estonia's Economic Development Trends, Practics and Sources. A Case Study. *World Bank Working Paper N0 25.*

Peneder, M. (2002). Structural Change and Aggregate Growth, WIFO Working Papers, N0 182/2002, Vienna.

Schettkat, R., Yocarini, L. (2003). The Shift to Services: A Review of th Literature. IZA Discussion Paper N0 96.

THE ROLE OF EXPORTS IN THE PROCESS OF GROWTH. AN ANALYSIS OF ITALIAN REGIONS USING A MULTI-REGIONAL INPUT-OUTPUT MODEL

Leonardo Ghezzi, Renato Paniccià, Stefano Rosignoli
IRPET Istituto Regionale Programmazione Economica Toscana
Regional Institute for Economic Planning of Tuscany

Introduction

The aim of this contribution is twofold. Firstly, to present the IRPET multiregional I-O model, and specifically: *i*) the method of estimating the main aggregates; *ii*) the structural form; *iii*) some evidence on the effects of regional trade. Secondly, as a case study, to shed some light on the role of foreign exports in Italian regional growth. Specifically, analysis focused on: *a*) the variations of the share of foreign exports in exogenous final demand over the last decade and *b*) the effects of the vertical increase in outgoing FDI (entailing increased import shares over GDP) on the export multiplier and, consequently, on the regional pattern of growth.

The paper is structured as follows: the first paragraph presents the multiregional I-O model, by explaining the method of construction, the structural form specification and by analysing the impact of interregional trade. The second paragraph introduced some stylised facts related to foreign trade characterizing the Italian regional economy. Finally, the multiregional impact of Italian foreign exports through regional multipliers is analysed.

1. The Multi-Regional Model

1.1 Some outlines on the construction of the multi-regional table

1.1.1 Balancing method

The method briefly described in this paragraph takes its cue from some of the constructive features of the previous (Casini Benvenuti, Martellato and Raffaelli 1995) IRPET models, and updates the methodology extensively described in Casini Benvenuti and Paniccià (2003) by taking into account the new accounting framework associated with the Supply

Maurizio Grassini and Rossella Bardazzi (edited by), *Energy Policy and International Competitiveness*,
ISBN 978-88-6453-040-6 (print) ISBN 978-88-6453-043-7 (online)

and Use tables (henceforth SUT) released by the Italian Central Statistical Office (ISTAT) since 2005.

The multi-regional table was estimated using the GLS estimator proposed by Stone *et al.* (1942) (henceforth SCM) later developed by Byron (1978) and presented in Appendix 2[1].

The balancing structure of the multiregional table is specified according to four main groups of constraints. Firstly, at a regional level, both the supply and demand of *products* and formation and use of *output* must be consistent (see eqs. *1.i* and *1.ii*). Secondly, consistency must also be achieved in relation to the national SUT, that is the sum of the regional SUT must be equal to the national sum except for interregional trade (see eq *1.vii*). Thirdly, constraints supplied from regional accounts must be fulfilled (see eqs. *1.iii* and *1.iv*), usually these data are provided in more aggregate form (value added, indirect taxes) or by components (see, for instance, final domestic demand). Fourthly, equality must be achieved between the interregional import and export flows of products at a national level (see eqs. *1.v* and *1.vi*).

[1.i] $$\mathbf{S}' \cdot \mathbf{i} + \mathbf{T}' \cdot \mathbf{i} + \mathbf{m} \equiv \mathbf{U} \cdot \mathbf{i} + \mathbf{F} \cdot \mathbf{i} + \mathbf{T} \cdot \mathbf{i} + \mathbf{e}$$

[1.ii] $$\mathbf{i}' \cdot \mathbf{S}' \equiv \mathbf{i}' \cdot \mathbf{U} + \mathbf{i}' \cdot \mathbf{Y}$$

[1.iii] $$\bar{\mathbf{Y}} \equiv \mathbf{Y} \cdot \mathbf{G}_Y$$

[1.iv] $$\bar{\mathbf{F}} \equiv \mathbf{F}' \cdot \mathbf{i}$$

[1.v] $$\mathbf{i} \cdot \mathbf{T}^{\star} \equiv \mathbf{T}^{\star} \cdot \mathbf{i}'$$

[1.vi] $$\mathrm{T}^{*} \equiv \ \cdot \mathrm{vec}(\mathrm{T})$$

[1.vii] $$\sum_{j=1}^{k} \begin{bmatrix} 0 & {}_{k}\mathbf{U} & {}_{k}\mathbf{F} & {}_{k}\mathbf{e} \\ {}_{k}\mathbf{S} & 0 & 0 & 0 \\ 0 & {}_{k}\mathbf{Y} & 0 & 0 \\ {}_{k}\mathbf{m}' & 0 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 0 & {}_{ita}\mathbf{U} & {}_{ita}\mathbf{F} & {}_{ita}\mathbf{e} \\ {}_{ita}\mathbf{S} & 0 & 0 & 0 \\ 0 & {}_{ita}\mathbf{Y} & 0 & 0 \\ {}_{ita}\mathbf{m}' & 0 & 0 & 0 \end{bmatrix}$$

[1] The main reasons why the SCM has been preferred to other methods is well summarized by Round J. (2003). The author presents a review of the most widely used balancing methods (about SAM balancing): rAs, Cross Entropy and SCM, and clearly expresses his opinion in conclusion (p. 179, par. 3) «[…] In spite of the apparent preference for the cross-entropy (CE) method by many compilers of SAMs, the Stone Byron method (SCM ed.) (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». Furthermore we could add that the SCM method is very sensitive to the degree of bias of the initial estimates forcing the analyst to focus more attention on those estimates than the other methods do, so it concurs with Round's recommendation in the same article «[…] It is a far better strategy to concentrate on improving the initial estimates and to use the smoothing techniques only in extremis or as final resort».

where[2]:

S = the blocks-diagonal regional Supply matrices $[(k \times m)x(k \times n)]$;
i = a column vector of proper dimension;
T = a multiregional trade flows matrix $[(k \times n)x(k \times n)]$ (off-blocks diagonal);
m = the vector of foreign import products $(k \times n)$;
U = the blocks-diagonal regional Use matrices $[(k \times n)x(k \times m)]$;
$\bar{\mathbf{F}}$ = the regional domestic final demand components constraints $[(k \times df)]$;
F = the blocks-diagonal regional domestic final demand matrices $[(k \times n)x(k \times df)]$;
e = the vector of foreign export products$(k \times n)$;
$\bar{\mathbf{Y}}$ = the blocks-diagonal regional primary input components constraints $[(k \times p)x(k \times m^{\star})]$;
Y = the blocks-diagonal regional primary input components $[(k \times p)x(k \times m)]$;
$\mathbf{G}_y$ = the aggregation matrix from m sectors to $m^{\star}$ industry supplied by regional accounts.

1.1.2 The initial estimates

A crucial step in balancing the multiregional table is the provision of an unbiased initial dataset. Unlike other methodologies (see for instance rAs) the SCM estimator is very sensitive to the initial data inserted in the balancing accounting system. Biased initial estimates could lead to either no convergence or to final values with an unexpected negative/positive sign. Far from being a weakness of the methodology, this is an important feature of the estimator because it can be interpreted as an important warning of inconsistencies in the matrix V (see appendix 2), or in the constraints and/or biases in the initial estimates. This may therefore be an incentive to check the components of the solution to the algorithm more carefully. We therefore found that Round's recommendation as in note 1, is particularly applicable when using the SCM method.

With reference to other publications giving a more detailed description of the estimate of the initial dataset we concentrated our attention on three important parts of the table.

[2] Given: k = *number of regions*; n = *number of products*; m = *number of sectors*; m★ = *number of sectors supplied by official regional accounts*; df = *domestic final demand components*; p = *primary input components*. See Appendix 2 for the detailed list of sectors and products.

Starting from the regional Use matrices, the estimate followed three complementary directions. First, a set of regionalized Use tables obtained through industry-mix[3] were used. The starting matrix was the national matrix B at a higher level of disaggregation. Secondly, for some industries, (especially machinery, electronic and transport equipment) the regional parameters extracted from the System of Enterprise Accounts survey were utilized. Thirdly, *ad hoc* figures and adjustments drawn from other sources were inserted in the Use tables[4].

Other important parts of the regional SUT are the Supply tables. In this case too we followed a dual estimate approach: *i*) we used a set of regionalized Supply figures obtained from the national Supply Table through industry mix *ii*) we also used *ad hoc* information on output composition.

The estimate of the trade flows between regions is one of the most relevant problems when building multi-regional I-0 tables, mainly because a lack of data concerning such trade is common. Much literature suggests using the class of gravity models derived from Newtonian physics[5] for estimating matrix T.

The Economic masses are represented by the total net output of foreign exports in the *r-th* region (the origin of flow) and the total domestic net demand of foreign imports in the *s-th* region (the destination of flow). We used the total amount of products of sector *i-th* to normalize the masses, and introduced an f(δ) that is the decay function. It may be hypothesised that such function should be inversely proportional to the economic distance, in other words, expressed through a set of variables.

The first variable to be included is the effective distance, as a proxy of the transport cost, between the *r-th* region and the *s-th* region. Its calculation is based on provinces (NUTS-3) making up regions, so the distance (in time) between two regions is equal to the average distance between their own provinces. This method permits the computation of

[3] Shen 1960.

[4] This was the case, for instance, for the production of electricity. The prevalence of different types of power plant amongst regions (from hydropower to thermoelectric power) implies a significant difference in the intermediary input structure.

[5] For a good recent review see Parve (2008). The main hypothesis basically suggests that the flows between two regions are directly proportional to their «economic masses» and inversely proportional to a decay (deterrence) function, which should represent the cost of transactions between the *r-th* and *s-th* region per *i-th s*ector . Following the Leontief-Strout (1963) formalization we can write:

$$ {}_{rs}t_i = ({}_rX_i \cdot {}_sD_i) / Q_i \cdot f({}_{rs}\delta_i) $$

The interregional flows between *r* and *s* are functions of the output mass X (expulsion force), from the demand mass *s* (attraction force), through a connection or decay function.

the distance of a region (diagonal of the matrix) as an average distance between the provinces of the same region.

Another explanatory variable is the propensity to intra-industry trade[6] which can be caused by:

a) industry based determinants (vertical product differentiation, vertical interregional production integration, cost structure);
b) regional characteristics (mainly income level) product;
c) the classification and its degree of aggregation.

This is a sector-specific variable and it was measured using the Grubel-Lloyd index[7] computed at a national level for foreign trade. The hypothesis is that, *ceteris paribus*, a higher propensity to intra-industry trade could reduce the effects of economic distance. Another sector-specific explanatory variable is the degree of tradability. This (see Bower et al. 1983) should indicate the propensity of products of a sector to be traded, given their physical features. This indicator was proxied by a trade openness index[8] computed at a national level. The relative regional economic size (share of GDP) should act as a region- specific factor.

Therefore, the deterrence model should be as follows:

[2] $_{rs}f_i = (_{rs}d, IIT_i, TRADE_i, _rSIZE)$ r, s = 1, number of regions; i = 1, number of sectors

where IIT = Grubel-Lloyd Intra Industry Trade index; d = effective distance; TRADE = degree of tradability; SIZE = region's economic size.

Problems arise in finding data on interregional trade. No data are available in value terms on interregional flows, the only information existing for estimating and testing the deterrence function, can be drawn from an ISTAT survey on commodities interregional flows (ISTAT 1998), in quantity (tons) and aggregated by 5 macro-sectors,

Given the high aggregation and the heterogeneity of the macro-sectors, we decided to perform a pooled (regions/sectors) regression, and following the recommendations in literature, our estimation strategy was as follows:

1) We computed the difference between the flow calculated without any deterrence function interaction and actual flows. This step made it

[6] At an interregional level see for instance Munroe-Hewings (2000), and in particular, Stone (1997) quoted in Munroe-Hewings.

[7] See Grubel H.G. and Lloyd P.J. (1971).

[8] The degree of openness is computed for each sector as $u_i=(ew_i+mw_i)/x_i$.

possible to isolate the effect of the decay function on the multi-regional flows. Our estimate was based on the data for commodity flows in quantity for five macro-sectors, so for each *k-th* of them, we wrote the following equation:

[3] $\quad {}_{rs}\phi_k = {}_{rs}Actual_i \;/\; {}_{rs}Expected_i$

where Expected = ($_{r.}$tons $_i$ ^{x} $_{.s}$tons $_i$)/ tons $_i$

2) once defined ${}_{rs}\phi_k$ this permitted estimation of the following pooled model in log-log specification:

[4]

$$\log({}_{rs}\phi_k) = a + b\cdot\log(1/{}_{rs}d) + c\cdot\log(IIT_i) + d\cdot\log(TRADE) + e\cdot\log({}_{r}SIZE)$$

r,s=1,number of regions; k = 1, number of macro-branches

In the footnote[9] are the results of regression, which are encouraging both in terms of good fit, parameter signs and specification tests.

We can extrapolate this function for all products by inserting the deterrence explanation variables in equation [5]. Remembering the symbolism of accounting framework equations [1] computing the initial, interregional trade flows should be expanded and modified as follows for each manufacturing product:

[5]

$$ {}_{rs}t^{\star}_{i} = a\cdot\left\{\left[({}_{r.}q_i - {}_{r.}e_i)\cdot({}_{.s}dt_i - {}_{.s}m_i)\right]/\,t_i\right\}\cdot\left[(1/{}_{rs}d)^b\cdot(IIT_i)^c\cdot(TRADE_i)^d\cdot({}_{r}SIZE)^e\right]$$

where the economic masses are represented by: product output less foreign export and domestic demand less foreign import

Another important component of the balancing process could be also added to the procedure. Indeed, the equation estimate produces a variance estimate which could be utilized as a proxy of reliability in matrix V.

[9] Parameters estimate of the deterrence function (Source: authors calculations on IRPET data):

Explanatory variables	Parameters	Standard Error	R-square bar
Intercept	0.8848416	0.338283	0.4971
1/distance	0.866112	0.050175	
IIT index	0.1377696	0.050724	df.
TRADE	0.4285248	0.073161	970
SIZE	-0.185568	0.102852	

1.2 The model structure

Once the multiregional SUT is estimated it is possible to proceed towards the ex-ante representation of I-O relationships. In doing so, the debate on technology representation (industry-product) has intentionally been skipped, a debate which we have borne in mind but which is not the focus of our paper. However the model was specified after an industry technology transformation along with symmetric, industry by industry I-O matrices.

The model is based on two main causal relations:

1) technical: the main determinant of the regional intermediary demand:
2) allocative: the determinant of production distribution among regions. Given the exogenous nature of the final demand, we can formalize them as follows:

[6.1] $d = A \cdot x + f$
[6.2] $x = T \cdot d$

Causation related to intermediate demand is measured by technical coefficients, as for the allocative pattern, by the interregional trade coefficients matrix T. This is the typical Chenery(1953)-Moses (1955) class of models, in between the pool approach (Leontief *et al.* 1977) and the pure interregional model (Isard 1960). In the model we assumed competitive interregional imports with regional output and foreign imports.

Below is the structural form:

[7] [*i*] $x + s_x + mw + mr = A \cdot x + d + c_x + ew + er$

[*ii*] $d = (c_k + g + i + div) \cdot (I - S_d)$

[*iii*] $c_x = (H \cdot x) \cdot (I - S_c)$

[*iv*] $ew = ewt \cdot (I - S_{ew})$

[*v*] $s_x = S_x \cdot A \cdot x$

[*vi*] $mw = \hat{M} \cdot (A \cdot x + d + c_x)$

[*vii*] $mr = B \cdot (I - M) \cdot \ (A \cdot x + d + c_x)$

[*viii*] $er = B \cdot (I - M) \cdot \ (A \cdot x + d + c_x)$

where:

x = Output at basic prices;
s_x = Net Taxes on intermediary products;
mw = Foreign imports (fob);
mr = Interregional imports;
df = Final regional domestic demand net of taxes on products;
ew = Foreign export (fob) net of taxes on products;
ewt = Foreign export (fob) gross of taxes on products;
er = Interregional exports;
c_k = Exogenous Household expenditure;
c_x = Endogenous Household expenditure;
g = Government and NPISHs expenditure;
i = Gross Fixed Investments;
div = Changes in inventories;
A = Intermediate input coefficients;
S_x = Net Product Taxes on intermediary product coefficients;
S_c = Net Product Taxes on final consumption product coefficients;
S_d = Net Product Taxes on final demand product coefficients;
S_{ew} = Net Product Taxes on foreign export product coefficients;
M = Foreign import coefficients;
B, B = Interregional import-export coefficients from transformation of the multi-regional trade flow coefficients matrix T. In particular:

[8] $$T = I - \hat{B} + B$$

The structural form is interpreted as follows: the initial identity defines the sectoral uses and resources as [7.*ii*] compounds the final domestic demand. Net taxation on intermediary input is linked to regional sectorial output (equation [7.*iv*]). In the equation [7.*v*] foreign imports are a function of total domestic demand, net of taxes on products, equations 7.*vi* and 7.*vii* explain the interregional trade both of imports and exports.

Household expenditure is divided into two components. The first – c_k – is exogenous and is made up of expenditure related to public transfers (mainly pensions) and non-resident consumption (mainly tourism). The second – c_x – is endogenous and linked to primary and partially secondary distribution represented in the parameters in H (equation [7.*iii*]). In equation [9] the reduced form of the model is shown :

[9]

$$x = \left\{ \left(I + S_x\right) - \underbrace{T \cdot \left(I - M\right)}_{R} \cdot \left[A + H\left(I - S_c\right)\right] \right\}^{-1} \cdot \left\{ \underbrace{\left[T \cdot \left(I - M\right)\right]}_{R} \cdot \underbrace{\left[d \cdot \left(I - S_d\right) + ew \cdot \left(I - S_{ew}\right)\right]}_{fd} \right\}$$

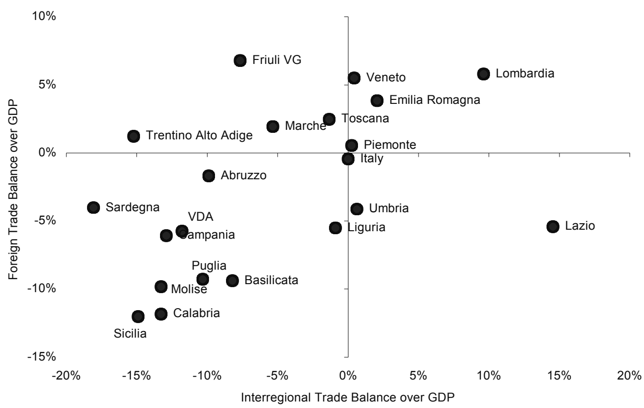
which could be written as:

$$[10] \quad x = \underbrace{\left\{ \left(I + S_x \right) - R \cdot \left[A + H \left(I - S_c \right) \right] \right\}^{-1}}_{INV} \cdot \left\{ R \cdot fd \right\}$$

1.3 Some multiregional evidence

The first information which can be drawn from the table is the interregional trade balance which is not usually available from the official statistics. These data could be combined with the foreign trade balance in order to evaluate the relative position of each region in terms of propensity to export/import abroad and/or inter-regionally.

Figure 1. Interregional and foreign trade balance over GDP.



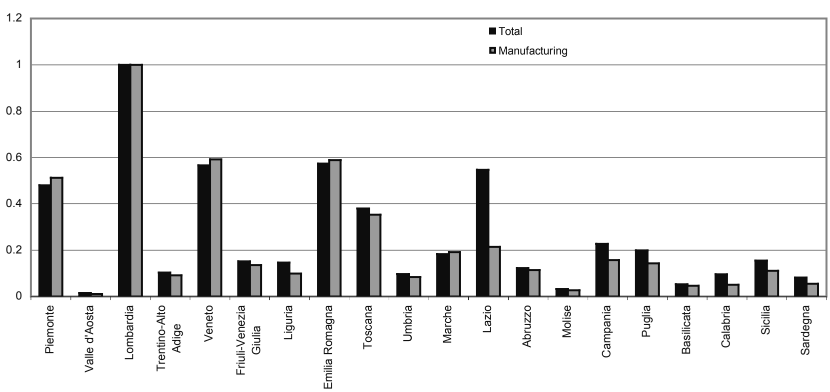
In figure 1 each region has been positioned according to both trade balances over GDP and an initial impression of the Italian regional division is given. Almost all the southern regions are in the bottom left corner which implies strong foreign and interregional trade deficits. Only Sardinia and Abruzzo[10] seem to have partially recovered their foreign deficit. In the top right quadrant are the leading regions (Lombardy, Piedmont, Veneto and Emilia-Romagna), however within this group one can observe the relative higher propensity to foreign trade of Veneto compared to the other

[10] Indeed Sardinia and Abruzzo are no longer in the EU Objective 1 eligible regions.

three regions. Tuscany is in the top-left quadrant (positive foreign trade and negative inter-regional trade) along with three other regions of the so-called NEC (North-East and Central Italy). Trentino Alto Adige is worth mention: despite its small economic dimension it has a structurally positive foreign trade balance. Another special mention should be made for Lazio: the higher positive interregional balance is strictly linked to its role as capital region and so a supplier to other regions of indivisible PA services.

Secondary structural information is represented by the role of interregional trade in commanding output. In estimating such parameters the methodology utilized in Costa- Martellato (1990, 1987) demonstrating that the latent variables related to the first eigenvalue of the multi-regional trade matrix T could be defined as the pure (dimensionless) variables relative (to a region) regional production activated by interregional trade could be applied. Having defined Lombardy as the benchmark region with a value of 1, the following graph shows how the output of the other regions is influenced by interregional trade in relation to Lombardy. The analysis was also performed for the whole economy and for the manufacturing macro-sector.

Figure 2. Relative regional output produced by interregional trade.



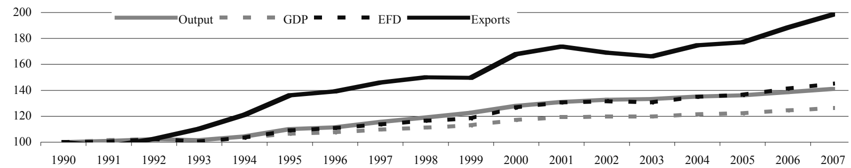
Not surprisingly, the regional output produced by interregional trade was only around 20% for Campania and Puglia (compared to the result of Lombardy) and, for the other regions the amount was well below this threshold. The pattern is even worsen if the macro manufacturing sector only is taken into account. Graph 2 also shows the relatively good position of Veneto, Piedmont and Emilia Romagna for which the relative output improves when the manufacturing sector alone is analysed. Quite interestingly, the different relative output of Lazio worsens dramatically when the analysis moves from the whole economy (with PA services) to the manufacturing sector alone.

2. *A case study: the role of exports in Italian regional growth*

2.1 A national point of view

Looking at the changes in Italian exogenous final demand components (foreign tourism consumption, investments, public expenditures, foreign exports) over time (Fig. 3), an acceleration from the mid-1990s to the new millennium can be observed. Vice versa the GDP dynamics show a lower rate than for exogenous final demand. The evidence that appears from ISTAT data on National Accounts seems to suggest that Italy experienced decreasing elasticity of GDP on exogenous final demand (henceforth EFD) and a stable relationship between EFD and output during that period. But, how much has the relationship between EFD and GDP changed?

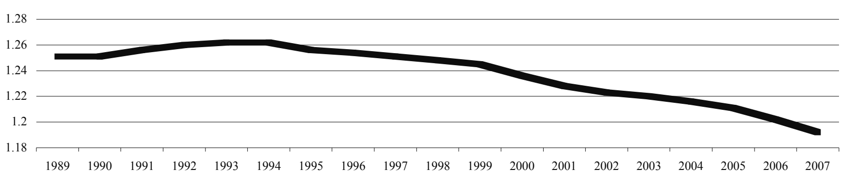
Figure 3. Exogenous demand and GDP yearly growth at constant prices. 1990=100.



Source: authors' calculations from ISTAT.

The Italian EFD-GDP multiplier has shown a steadily decreasing path for the last two decades. As a result, the same absolute variation of EFD generated a smaller direct, and indirect increase in GDP than 10 years ago, while in 1990 the GDP multiplier of EFD was about 1.26, in 2007 it reached 1.19.

Figure 4 Evolution of the GDP multiplier of EFD, Italy.



Source: authors' calculations. Recursive estimation based on the sample 1970-2007, constant price.

An important component of EFD is represented by foreign exports which is one of the most important driving forces in the process of economic growth both in the short and long term (Thirlwall 1979; Thirlwall, McCombie 1994; Setterfield 2002). Over the last two decades a rapid growth of exports can be observed but at the same time, as for

EFD, a declining variation in the impact of exports over GDP in short run growth (see Table 1) is seen. How can we explain that?

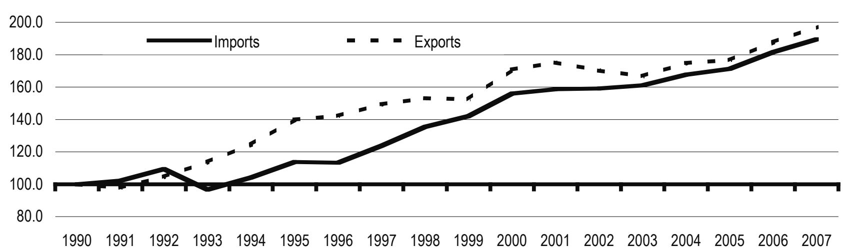
Table 1. Aggregate Multiplier and share of exports, Italy.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GDP multiplier of export	1.180	1.176	1.170	1.164	1.158	1.141	1.125	1.115	1.110	1.102	1.092	1.084	1.075
- Output multiplier of GDP	2.291	2.292	2.292	2.292	2.295	2.294	2.293	2.294	2.296	2.296	2.294	2.288	2.282
-Fabrication coefficient	0.515	0.513	0.511	0.508	0.505	0.497	0.491	0.486	0.483	0.480	0.476	0.474	0.471
Share of exports on GDP	0.219	0.221	0.228	0.231	0.227	0.245	0.249	0.241	0.237	0.246	0.248	0.259	0.269
- Share of EFD on GDP	0.626	0.628	0.633	0.639	0.639	0.661	0.669	0.671	0.667	0.678	0.683	0.694	0.703
- Share of exports over EFD	0.349	0.352	0.359	0.361	0.355	0.371	0.373	0.360	0.356	0.362	0.363	0.373	0.382
- Share of Imports on Domestic Demand	0.125	0.117	0.122	0.125	0.125	0.140	0.139	0.134	0.131	0.134	0.140	0.151	0.155
- Share of Imports over GDP	0.219	0.201	0.214	0.221	0.226	0.261	0.257	0.248	0.240	0.246	0.260	0.287	0.295

Source: authors' calculations.

First of all, over the last two decades, the share of exports over GDP steadily grew. While in 1995 exports accounted for about 21.9% over GDP this figure reached 24.9% in 2001 and 27% at the end of the period of analysis. Nonetheless during the same period Italy experienced an increase in imports and above all in import shares over both total demand and GDP (table 1) which offset this. As is clear from figure 5, the dependence of the Italian economic structure on imports increased over recent years.

Figure 5 Real growth of imports and exports. 1990=100.



Source: authors' elaborations.

This evolution implies that the growth of foreign sales took place with a limited effect on the production of Italian firms and so we should observe, in addition to a general increase of the share of exports over GDP, a very slight reduction of the output multiplier.

However Italy is characterized not only by a general process of globalisation but specifically this country is involved in a deep outsourcing process through increasing flows of vertical FDI (Table 2). This is the situation that can be seen from the data in table 2. This process implies, in addition to a higher share of exports and a slight reduction of the output multiplier, a reduction in the value-added coefficient.

Table 2. Italian outgoing vertical FDI. Firms and employees.

Year	Outgoing FDI - n. of enterprises	Employees
1986	282	244,188
1991	475	517,796
1996	124	655,039
2001	2,664	833,740
2002	2,734	888,375
2003	2,752	877,355
2004	2,792	873,763

Source: REPRINT, Mariotti and Mutinelli.

So the reduction of export-GDP multiplayer is only very partially due to changes in the output multiplier, a more significant role could be assigned to the outsourcing process.

Nonetheless that process is not the only cause of a diminishing export-GDP multiplier. How the changes in the sectoral mix of Italian exports could have affected that variable should also be taken into consideration.

To isolate this factor a simple decomposition of the variation in the aggregate GDP multiplier of Exports (ΔAME) may be specified.

$$[11] \quad \Delta AME = \sum_i \Delta SME_i \cdot W_{i,initial} + \sum_i SME_{i,initial} \cdot \Delta W_i + \sum_i \Delta SME_i \cdot \Delta W_i$$

where: ΔSME_i is the change from one year to the next in the value added multiplier of sector i; $W_{i,\,initial}$ is the weight of exports of sector i on total exports in the initial year; $SME_{i,\,initial}$ is the value added multiplier of sector i in the initial year; ΔW_i is the change in the weight of sector i. The first addend on the right side of [11] may be call the «sector multiplier» effect, the second may be called the «sector share» effect, and the third element is a residue. To understand the role of the export mix we should observe that different goods or services stimulate different levels of value added in the Italian economic system and so a variation of the weights of sectoral exports could generate a change of the aggregate GDP multiplier (sector share effect). At the same time we have to consider that over the last two decades not only may the composition of the exports basket have changed but the sector multiplier too could have altered (sector multiplier effect).

We can observe the dynamics of the sector multiplier using national input-output tables estimated by IRPET in the period 1995-2005. From a sectoral perspective we have observed that a considerable contribution to the decrease of the aggregate GDP multiplier derives from industry. In particular, about 55% of this reduction is attributable to Textiles and Leather, about 27% to Machinery, Electrical and Transport equipment. The evolution of Chemicals has produced, ceteris paribus, an increase in the aggregate GDP multiplier.

In particular, in Italy we observed a lowering of many sector multipliers in relation to value added (see table 3): about 86.6% of the decrease was caused by this. There was also a variation of the sectoral mix of exports. This evolution implied a slight reduction of the aggregate GDP multiplier: as we can see in table 3 only 8.3% of the decrease observed in the GDP multiplier was caused by this effect. This evidence confirms that one of the most important causes of the reduction observed in the aggregate GDP multiplier of exports during this period was the outsourcing process.

Table 3. Percentage contribution to variation of the Aggregate GDP multiplier. Sector multiplier effect and sector share effect.

Description	Variation of sector multiplier effect	Variation of sector share effect	Residual	TOTAL
Agriculture, hunting and forestry	-1.0	-4.5	0.2	-5.4
Fishing	0.0	0.0	0.0	0.0
Mining of energy producing materials	0.0	0.2	0.0	0.2
Mining of non energy producing materials	-0.2	-0.5	0.0	-0.6
Food products, beverages and tobacco	-2.2	1.7	-0.1	-0.6
Textiles and textile products	-10.3	-30.3	2.6	-37.9
Leather and leather products	-4.3	-13.2	1.0	-16.5
Wood and wood products	-0.5	-1.0	0.1	-1.4

Pulp, paper and paper products	-0.8	-4.1	0.1	-4.8
Coke, refined petroleum products and nuclear fuel	-1.9	15.0	-6.5	6.6
Chemicals, chemical products and man-made fibres	-8.8	19.2	-2.1	8.3
Rubber and plastic products	-3.6	1.0	-0.1	-2.7
Other non-metallic mineral products	-2.5	-12.2	0.7	-14.0
Basic metals and fabricated metal products	-7.7	18.5	-1.3	9.6
Machinery and equipment n.e.c.	-11.2	-3.5	0.2	-14.6
Electrical and optical equipment	-4.3	0.5	0.0	-3.8
Transport equipment	-9.9	1.6	-0.2	-8.5
Manufacturing n.e.c.	-3.9	-17.7	1.0	-20.6
Electricity, gas and water supply	-0.2	0.6	-0.1	0.3
Construction	-0.1	-1.2	0.0	-1.3
Wholesale and retail trade	-7.4	9.3	-0.5	1.4
Hotels and restaurants	0.0	-0.2	0.0	-0.2
Transport, storage and communication	-3.3	-7.0	0.3	-10.0
Financial intermediation	-0.7	1.5	-0.1	0.8
Business activities, R&D and IT	-1.2	8.2	-0.2	6.8
Public administration	0.0	0.0	0.0	0.0
Education	0.0	-1.0	0.0	-1.0
Health and social work	0.0	-0.1	0.0	-0.1
Other community, social and personal service	-0.2	0.4	0.0	0.3
Real estate and renting	-0.3	10.3	-0.3	9.8
TOTAL	-86.6	-8.3	-5.1	-100.0

Source: authors' calculations.

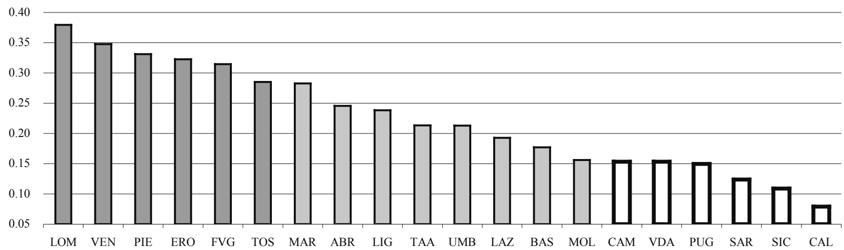
Both elements (outsourcing and exports composition) have reduced the level of the GDP multiplier of exports. But at the same time we also have to consider the share of exports in exogenous final demand. The mixed effect of both these elements implies that a variation of 1% of exports in 1995 produced about the same variation (about 0.3%) in GDP as in 2007 and so the elasticity of GDP to exports was roughly constant during this period.

2.2 Role of exports from a regional point of view

The different growth patterns of Italian regions imply a different set of structural parameters and therefore different responses to exogenous impulses.

According to the multiregional I-O model presented in the first paragraph it is possible to estimate the elasticity of regional GDP to foreign exports.

Figure 6. Elasticity of regional GDP to national foreign exports.

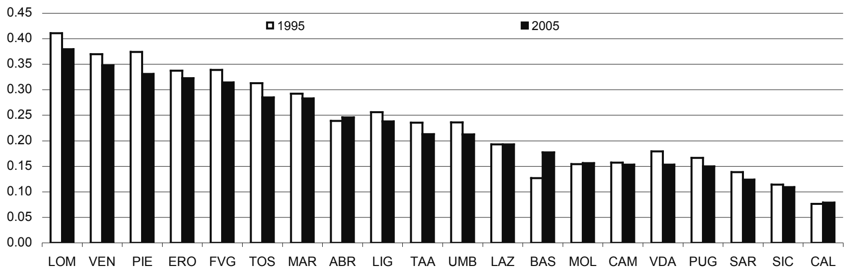


Source: authors' calculations.

Figure 6 shows paradigmatic evidence. As we can see, foreign exports are a very important driver of growth in the more developed regions. In such regions there is a strong manufacturing production system as well as a more open economy. Specifically, the northern-central regions experienced in 2003 an elasticity of GDP to foreign exports ranging from 0.38 (Lombardy) to 0.28 (Marche). This implies that 1% of growth in national foreign exports determines growth of about 0.3/0.4% in these systems. On the other hand, southern regions are lagging behind and the increase in foreign exports does not affect regional growth significantly, indeed there, elasticity ranges from 0.15 (Campania) to 0.08 (Calabria).

As results of this, any pro-quota increase in national foreign exports leads to an increase in divergence amongst Italian regions. The same analysis performed on the 1995 multi-regional table shows a similar region-wide pattern (Figure 7).

Figure 7 Elasticity in 2005 vs. elasticity in 1995.



Source: authors' calculations.

But what is the role of interregional trade in producing such elasticity? This paper sets out to focus analysis on the transmission amongst regions of foreign export impulses. Foreign exports of a single region set in motion the productive structure of that specific region but, through inter-regional trade, also the productive structure of other regions. By using a multi-regional input-output model we calculate the spillover balance (outgoing – incoming).

Table 4. Regional spillover of value added – incoming and outgoing. 2005. Millions of euro.

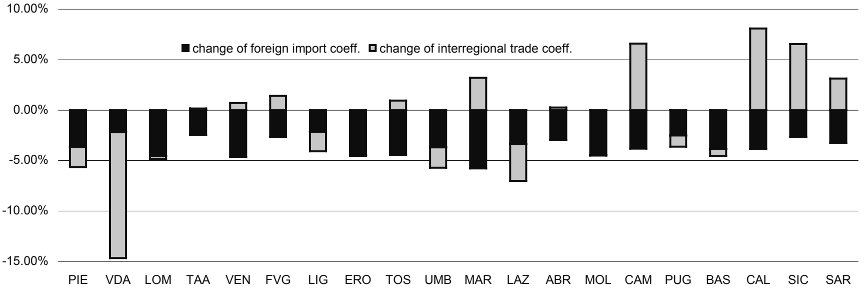
	spillover of value added (1)	Value added stimulated by foreign exports of other regions (2)	Value added stimulated by total foreign exports of Italy (3)	Share of balance in value added stimulated by total foreign exports of Italy (2 – 1) / 3	Share of foreign exports (%) in total national exports
PIE	10759.2	8979.1	34178.9	–5.2%	11.1%
VDA	163.2	263.4	492.1	20.4%	0.1%
LOM	19404.7	19843.0	95860.1	0.5%	29.0%
TAA	2023.6	2031.4	5743.5	0.1%	1.6%
VEN	13773.3	9514.0	38515.1	-11.1%	13.7%
FVG	4028.3	2727.9	9218.3	-14.1%	3.1%
LIG	2034.8	3052.4	8878.9	11.5%	2.1%
ERO	12106.6	10387.2	34781.2	–4.9%	11.1%
TOS	8425.3	7131.4	23606.5	–5.5%	7.4%
UMB	1228.6	1785.8	3654.8	15.2%	0.9%
MAR	3803.5	2795.4	8919.4	-11.3%	3.0%
LAZ	4134.3	8605.8	24714.1	18.1%	5.9%
ABR	2634.3	1870.8	5638.4	-13.5%	1.9%
MOL	281.3	443.8	821.9	19.8%	0.2%
CAM	3401.6	4431.2	12527.7	8.2%	3.0%
PUG	2434.8	3357.5	8572.6	10.8%	2.1%
BAS	793.1	610.9	1576.5	-11.6%	0.5%
CAL	243.5	1581.6	2186.0	61.2%	0.2%
SIC	1690.2	2845.1	7837.9	14.7%	2.2%
SAR	746.7	1612.6	3281.2	26.4%	0.9%

Source: authors' calculations.

Table 4 shows the interregional spillovers of value added caused by regional foreign exports. And so, for instance Piedmont's foreign exports create value added in the other regions of 10,759 million euro. At the same time, Piedmont receives an impulse generated by the foreign exports of other Italian regions and this creates value added in Piedmont of 8,979 million euro, so the balance for Piedmont is negative. By analysing the results in table 5 a significant feature emerges: some low export-oriented regions like Calabria, Sicily, and Campania are characterized by a positive balance. Obviously, this feature is not linked to the strength of the economic structure. As a matter of fact, these regions are known to be fragile economies in the Italian context. The explanation of the positive balance observed in table 4, derived from the absolute level of foreign exports achieved by a region, is relevant. The more a region exports, the more a region generates a value added spillover. And so, a region with low exports creates a small spillover but it can take advantage of a kind of trickle-down effect from the other, higher exporting regions. This implies that, ceteris paribus, a lower level of foreign exports is linked to a higher balance. As can be noted in Table 4 Calabria, Sicily, and Campania are characterized by a very low level of exports out of total Italian exports.

Widening the analysis to interregional flows has made it possible to identify multiregional trade in the estimate of the regional impact of foreign exports. To stress this aspect, simulation using the multi-regional input-output model could be performed. The effect on GDP caused by foreign exports observed in 2005, using the model built on the input-output table for 2005 (model-1) was measured and we compared this to the level of GDP caused by the same exports using a different multi-regional input-output model (model-2). The latter model was built using technical coefficients for 2005 but foreign import coefficients for 1995. Differences between the results depended on a different structure of foreign imports. We made a second simulation changing the inter-regional trade patterns (model-3).

Figure 8. Regional effects on GDP of change (1995 vs 2005) in foreign import coefficients and interregional trade coefficients.



Source: authors' calculations.

The simulation results are summarised in Fig. 8. The black bar indicates the difference between the level of GDP produced by the «pure» model of 2005 (model-1) and the «hybrid» model (model-2). The difference is negative for all regions. This indicates that if we had today the same foreign import coefficients observed in 1995, we would obtain a higher level of GDP in all regions. This is the consequence of globalisation (not only more exports, but also more imports) and is similar for every region.

The grey bar indicates the difference between the GDP activated by model-1 and the «hybrid» model-3. Heterogeneous regional behaviour can be observed. Regions with a positive difference imply that if they have maintained the same inter-regional pattern, they would have obtained a lower level of GDP in 2003. The difference is positive for Calabria, Sicily, Campania, Sardinia, Marche.

Appendix 1. Regions, sectors and products in the Supply and Use multiregional table

REGION
Piedmont
Valle d'Aosta
Lombardy
Trentino-Alto Adige
Veneto
Friuli-Venezia Giulia
Liguria
Emilia Romagna
Tuscany
Umbria
Marche
Lazio
Abruzzo
Molise
Campania
Puglia
Basilicata
Calabria
Sicily
Sardinia

Sector	Description	Code
A	Agriculture, hunting and forestry	1
B	Fishing	2
CA	Mining and quarrying of energy producing materials	3
CB	Mining and quarrying, non energy producing materials	4
DA	Food products, beverages and tobacco	5
DB	Textiles and textile products	6
DC	Leather and leather products	7
DD	Wood and wood products	8
DE	Pulp, paper and paper products	9
DF	Coke, refined petroleum products and nuclear fuel	10
DG	Chemicals, chemical products and man-made fibres	11
DH	Rubber and plastic products	12
DI	Other non-metallic mineral products	13
DJ	Basic metals and fabricated metal products	14
DK	Machinery and equipment n.e.c.	15
DL	Electrical and optical equipment	16
DM	Transport equipment	17
DN	Manufacturing n.e.c.	18
E	Electricity, gas and water supply	19
F	Construction	20
G	Wholesale and retail trade	21
H	Hotels and restaurants	22
I	Transport, storage and communication	23
J	Financial intermediation	24
72 - 73 - 74	Business activities, R&D and IT	25
L	Public administration	26
M	Education	27
N	Health and social work	28
O-P-Q	Other community, social and personal service activities	29
70 - 71	Real estate and renting	30

Products	Description
01	Agriculture, hunting and related service activities
02	Forestry, logging and related service activities
05	Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing
10	Mining of coal and lignite; extraction of peat
11	Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction (
12	Mining of uranium and thorium ores
13	Mining of metal ores
14	Other mining and quarrying
15	Food products and beverages
16	Tobacco products
17	Textiles
18	Wearing apparel; dressing and dyeing of fur
19	Tanning and dressing of leather; luggage, handbags, saddlery, harness and footwear
20	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials
21	Pulp, paper and paper products
22	Publishing, printing and reproduction of recorded media
23	Coke, refined petroleum products and nuclear fuel
24	Chemicals and chemical products
25	Rubber and plastic products
26	Other non-metallic mineral products
27	Basic metals
28	Fabricated metal products, except machinery and equipment
29	Machinery and equipment n.e.c.
30	Office machinery and computers
31	Electrical machinery and apparatus n.e.c.
32	Radio, television and communication equipment and apparatus
33	Medical, precision and optical instruments, watches and clocks
34	Motor vehicles, trailers and semi-trailers
35	Other transport equipment
36	Furniture; manufacturing n.e.c.
37	Recycling
40	Electricity, gas, steam and hot water supply
41	Collection, purification and distribution of water
45	Construction
50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel
51	Wholesale trade and commission trade services, except of motor vehicles and motorcycles
52	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and hous
55	Hotel and restaurant services
60	Land transport and transport via pipeline services
61	Water transport services
62	Air transport services
63	Supporting and auxiliary transport services; travel agency services
64	Post and telecommunication services
65	Financial intermediation services, except insurance and pension funding services
66	Insurance and pension funding services, except compulsory social security services
67	Services auxiliary to financial intermediation
70	Real estate services
71	Renting services of machinery and equipment without operator and of personal and household good
72	Computer and related services
73	Research and development services
74	Other business services
75	Public administration and defence services; compulsory social security services
80	Education services
85	Health and social work services
90	Sewage and refuse disposal services, sanitation and similar services
91	Membership organisation services n.e.c.
92	Recreational, cultural and sporting services
93	Other services
95	Private households with employed persons

Appendix 2. The SCM balancing procedure

The main hypothesis assumes that the flows to be balanced are subject to accounting constraints and can vary according to the relative reliability of the preliminary estimate. Instead of the linear bi-proportioning rAs, the concept of variance and covariance (Var-Cov), associated with the reliability of the initial accounting set T(0) is explicitly introduced. The solution proposed by the authors consists of applying a GLS estimator to the following problem: given an accounting matrix T (vectorization t) subject to k number of constraints, according to the aggregation matrix G:

$$[1] \quad k = G \cdot t$$

Using the initial estimate T(0) we get:

$$[2] \quad k + \varepsilon = G \cdot t(0)$$

Assuming that the initial estimate T(0) is unbiased and has the following characteristics

$$[3] \quad t(0) = t(1) + \varepsilon$$
$$E(\varepsilon) = 0$$
$$E(\varepsilon\varepsilon') = V$$

The use of GLS will therefore lead to the estimate of a vector t* (1) that will satisfy the accounting constraints in [1] and will be as near as possible to the actual data t (1).

The estimator able to produce such an estimate is as follows:

$$[4] \quad t^*(1) = (I - V \cdot G' \cdot (G \cdot V \cdot G')^{-1} \cdot G) \cdot t(0) + V \cdot G' \cdot (G \cdot V \cdot G')^{-1} \cdot k$$

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

$$[5] \quad V = V - V \cdot G' \cdot (G \cdot V \cdot G')^{-1} \cdot G \cdot V$$

A seminal contribution to the development of the SCM method was provided by R.P. Byron (1977; 1978). According to the author the SCM estimator can be seen as a solution to a minimization of a quadratic loss function of the kind:

$$[6] \quad \vartheta = .5 \cdot \left(t^\star(1) - t(1)\right)' \cdot V^{-1} \cdot \left(t^\star(1) - t(1)\right) + \lambda \cdot \left(G \cdot t^\star(1) - k\right) = \min$$

where:

ϑ = quadratic loss
λ = Lagrange multipliers

The first class conditions for minimizing the previous equation correspond to the following values of Lagrange multipliers:

$$[7.1] \quad \lambda = (G \cdot V \cdot G)^{-1} \cdot (G \cdot t(0) - k)$$

so:

$$[7.2] \quad t^\star(1) = t(0) - V \cdot G' \cdot \lambda^\star$$

which refers back to the estimator in [4]. The contribution of R.P. Byron has made it possible 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 of the matrix $(GVG')^{-1}$. R.P. Byron proposed the conjugate gradient algorithm to reach an estimate of the Lagrange multipliers, by means of the system of linear equations:

[7.3] $(G \cdot V \cdot G') \cdot \lambda = (G \cdot t(0) - k)$

Since GVG' is symmetric defined positive, the conjugate gradient method provides a good solution of the λ coefficients. As also stressed recently (Nicolardi 1999), even with very powerful computers, this method retains advantages compared to direct estimates using eq. [7.3] of large systems of accounts to balance. These are:

1) the increasing control provided by the algorithm over possible inconsistencies of the initial estimates and of the Var-Cov matrix;
2) the possibility of avoiding the numerical instability associated with the inversion of the sparse matrix GVG'.

References

Antonello P. (1995). On balancing national accounts, in *Social Statistics, National Accounts and Economic Analysis: International Conference in memory of Sir Richard Stone*. Annali di Statistica serie X, vol. 6, Rome ISTAT.

Bacharach M. (1970). *Biproportional Matrices and Input-Output Change.* Cambrige University Press.

Barker T., Van Der Ploeg F., Weale M. (1984). A Balanced System of National Accounts for the United Kingdom. *Review of Income and Wealth*.

Batten D.F., Martellato D. (1988). Modelling interregional trade within Input-Output systems. *Ricerche Economiche.*

Bayerl N., Fritz O., Hierländer R., Streicher G. (2008). Exports, Services and Value Added. A National, International and Regional Analysis for Austria. *FIW Research Report*, n. 8, 2008.

Bayerl N., Fritz O., Hierländer R., Streicher G. (2008). The National and Regional Impacts of Exports on Value Added. *Paper presented at the International Input-Output Meeting on Managing the Environmental*, Seville.

Bower J.R., Ehrlich D.J., Stevens B.H., Treyz G. (1983). A New Technique for the Construction of Non-Survey Regional Input-Output Models. *International Regional Science Review,* n. 3.

Bracalente B., Daddi P., Di Palma M. (1981). Il dare e l'avere nei rapporti Nord-Sud Italia. *Quaderni ISRIL*, 1-2.

Byron R.P, Crossman P.J., Hurley J.E, Smith S.C.E. (1995). Balancing Hierarchical Regional Accounting Matrices, in *Social Statistics, National Accounts and Economic Analysis: International Conference in memory of Sir Richard Stone.* Annali di Statistica serie X, vol. 6, Rome, ISTAT.

Byron R.P. (1977). Estimate and Inference for Large Econometric Systems. *Econometrica.*

Byron R.P. (1978). The Estimate of Large Social Accounting Matrices. *Journal of the Royal Statistical Society*, Series A, Part 3.

Casini Benvenuti S., Cavalieri A., Grassi M., Martellato D. (1987). *Domanda, occupazione ed ambiente nel sistema input-output toscano.* Milan, FrancoAngeli.

Casini Benvenuti S., Grassi M. (1985). *Matrici e modelli input-output: il caso della Toscana.* Milan.

Casini Benvenuti S., Martellato D., Raffaelli C. (1995). Intereg: A Twenty-region Input-Output model for Italy. *Economic System Research* 44.

Chenery H.B. (1953). Process and production functions from engineering data. In: Leontief, W *et al.* (eds.) *Studies in the structure of the american economy*, Oxford University Press.

Chenery H.B. (1953). Regional analysis. In: Chenery H.B., Clark P., Cao Pinna V. (eds.), *The structure and growth of the italian economy.* Rome, US Mutual Security Agency.

Costa P., Martellato D. (1987). Intereg un modello multisettoriale, multiregionale per l'Italia. In: *Ricerche quantitative e basi statistiche per la politica economica*, Rome, Banca d'Italia.

D'Antonio M., Colaizzo R., Leonello G. (1988). Mezzogiorno/Centre-North: A two region model for the italian economy. *Journal of Policy Modelling.*

De Backer K., Yamano N. (2007). *Globalisation Measurement Using International Input-Output Tables.* Paper presented at the International Input-Output Meeting, Istanbul.

Fachin S., Venanzoni G. (2002). IDEM an integrated demographic and economic model for Italy. *CONSIP*, paper presented at XXIV International I-O Conference in Montreal.

Ferrara B. (1978). *Nord-Sud: interdipendenza di due economie*. Milan, FrancoAngeli.

Harrigan F., Buchanan I. (1984). A Quadratic Programming Approach to Input-Output Estimate and Simulation. *Journal of Regional Science.*

Hewings G.D.J, Jensen R.C. (1986). Regional, interregional, multiregional input-output analysis. In: Nijkamp, P., Mills, E.S. (eds.), *Handbook of regional and urban economics.* Amsterdam, North-Holland.

Isard W. (1951). Interregional and regional input-output analysis: a model for spatial economy. *Review of Economics and Statistics*, 33 (4).

Isard W. *et al.* (eds.) (1998). *Methods of interregional and regional analysis*. Aldershot.

Israelevich P.R. (1991). The construction of Input-Output Coefficients with Flexible Functional Forms. In: Dewhurst J., Hewings G. and Jensen R. (eds), *Regional Input-Output Modelling.* Avebury.

ISTAT (1998). Matrice regionale origine-destinazione dei beni trasportati: anno 1993, Sistema statistico nazionale. Rome, ISTAT

ISTAT (2000). Tavola intersettoriale dell'economia italiana: anno 1992, *Collana informazioni*. Rome, ISTAT

Juster F.T, Land K.C. (eds.) (1981). *Social accounting systems: essays on the state of the art.* New York/London: Academic Press.

Lavanda I., Rampa G., Soro B., Stella L. (1997). La revisione delle tavole intersettoriali 1970-1990: metodi procedure e primi risultati. Paper presented at the seminar *La contabilità nazionale nella transizione verso il SEC95,* Rome, ISTAT.

Leontief W., Carter A., Petri P. (1977). *The future of the world economy.* Oxford University Press.

Leontief W., Strout A. (1963). Multiregional input-output analysis, in Barna T. (ed.), *Structural interdipendencies and economic development*, London, St. Martin Press.

Mantegazza S., Mastrantonio L. (2000). Il Bilanciamento dei Conti: Situazione Attuale e Prospettive Future. Paper presented at the seminar *La nuova Contabilità Nazionale*, Rome 12/13.

Moses L.N. (1955). The stability of interregional trading patterns and input-output analysis. *American Economic Review.*

Munroe D.K., Hewings G.D.J (2000). The role of intraindustry trade in interregional trade in the Midwest of the US. *REAL Discussion paper.*

Nicolardi V. (1999). Un Sistema di Bilanciamento per Matrici Contabili di Grandi Dimensioni. *ISTAT Quaderni di Ricerca.*

Paniccià R. (2000). Un sistema di costruzione di matrici contabili regionali: metodologia e primi risultati. In: Casini Benvenuti, S. (ed.), *Il nuovo sistema dei conti economici nazionali e regionali SEC 1995*, Milan, FrancoAngeli.

Parve R. (2008). *On the Applicability of Gravity Approach when Modelling Sectoral Trade Flows*. mimeo.

Pilloton F., Shachter G. (1983). *Input-Output in Italy: a multiregional system, 1959-1965-1969-1972.* Rome, Casa del Libro.

Shen T.Y (1960). An Input-Output Table with Regional Weights. *Papers of Regional Sciences Association*, n. 6.

Stone R. (1961). *Input-Output and national accounts.* Paris, OECD.

Stone R. (1981). The relationship of Demographic Accounts to National

Income and Product Accounts. In: Juster F.T, Land K.C. (eds.), *Social accounting systems: essays on the state of the art*, New York/London: Academic Press, 1981.

Stone R. (1990). Adjusting the National Accounts. *Annali di Statistica series IX,* vol. 9, ISTAT, Roma.

Stone R., Champernowne D.G., Meade J.E. (1942). The Precision of National Income Estimates. *The Review of Economic Studies*, IX.

Svimez (2000). *Stima del reddito disponibile per il Nord-Centro ed il Sud Italia.* mimeo

Van Der Ploeg F. (1982). Reliability and the Adjustment of Sequences of Large Economic Accounting Matrices. *Journal of the Royal Statistical Society*, series A, vol. 145.

Weale M.R. (1988). The Reconciliation of Values, Volumes, and Prices in the National Accounts. *Journal of Royal Statistical Society*, series A, vol. 151.

Zakarias G., Fritz O., Kurzmann R., Streicher G. (2002). Comparing Regional Structure Change – An Application of Economic Input-Output Models. InTeReg Working Paper Series, 18, Graz-Vienna.

TINYTURK, A TINY MODEL BASED ON TURKISH DATA. FIRST STEPS TO BUILDING AN INFORUM MODEL

Paul Salmon
Faculté des Sciences économiques de l'Université de Rennes 1

Gazi Özhan
Faculty of Economic and Administrative Sciences,
European University of Lefke

1. *Introduction*

TINYTURK is a «Tiny model» as Clopper Almon defines in his book, *The Craft of Economic Modeling*[1]. Thus, TINYTURK is «a simple input-output model using only commands available in G»[2]. The main difference between TINY and TINYTURK is obviously that the data of the latter are the data of the Turkish economy and not a special structure created for US statistics. Consequently, the structure of the last Turkish 2002 Input-Output table, which applies the ESA 95 recommendations, is different from the structure of Tiny. From this point of view, we can consider TINYTURK as an application of the Tiny concept to an ESA 95 Input-Output framework.

To build TINYTURK, we used the 2002 Input-Output Table, in Basic prices, Current Prices and a table containing the components of GDP by expenditure for the period 1998-2007[3]. These two tables did not match very well. This is the consequence of a revision of GDP in March 2008[4]. We adopted several assumptions to build our model. Below are all the explanations for our choices.

Otherwise, we scrupulously followed the instructions of Almon's book with very few marginal adaptations especially in the building of the Vam file. These adaptations were necessary to take into account some problems of Turkish data and ESA 95.

The main difference between the two input-output tables is in the number of products and in the description of the economy. There are eight products in TINY and fifty-nine in TINYTURK. The compo-

[1] Almon (2008).

[2] Almon (2008), Part III, Multisectoral models, p. 15.

[3] The data files are available on Turkstat.

[4] To get more information on the revised GDP estimates, consult: <http://www.turkstat.gov.tr/jsp/duyuru/upload/13032008gdpeng.pdf>.

Maurizio Grassini and Rossella Bardazzi (edited by), *Energy Policy and International Competitiveness*,
ISBN 978-88-6453-040-6 (print) ISBN 978-88-6453-043-7 (online)

nents of final demand are defined differently in the two files. Readers of *The Craft of Economic Modeling*, Part III, will have a good idea of this work. As mentioned by Almon, it will be seen that TINY «gives a very nice idea, in very simple words, of what an input-output model is».

2. National accounts, Input- output, data and identities

Turkey has a long history of collecting statistical information. This history first began in the 14th century with the first land-population censuses in 1326-1360 and 1360-1389. More recently, Turkish Statistical Law published in the Official Gazette numbered 25997 on November,18th 2005 and entering into force on the same day had a direct impact on our work. The 2002 Input-Output table was the consequence of this law. The new law was adopted in accordance with Turkey's commitments to the statistical system applied in EU countries.

So nowadays, Turkey is in an unusual situation, between a previous system based on SNA 68 and the new one following the Turkish Statistical Law based on ESA 95[5]. This is both bad news and good news at the same time. To build a model with the data available in SNA 68 concepts is not a good project. It involves a lot of work and has almost no future. In the near future, may be no later than in three years' time, we believe we will have all the information we need to build a very useful intersectoral model for Turkey. Below, we will show how to begin building this new Turkish model and introduce the data available today in ESA 95 concepts.

2.1 Turkish input-output table and GDP by expenditure

When we first looked for the available input-output tables for our work, we saw that Turkey has a lot of them and dating far back. The first table was built for 1959 in the early 1960s after the establishment of the State Planning Organization by the military *coup d'état* government in May 1960. Therefore, the 2002 Input-Output table, the most recent one, is the tenth table in a series. It seemed, at this stage , that it would be possible to create a nice series of tables. Unfortunately, this was not the case. Classification problems, concepts used to build the table (SNA 1968 for all the tables except the last one ESA 95); access

[5] For further information on the history of statistics in Turkey, see <http://www.turkstat.gov.tr/UstMenu.do?metod=tarihce>. To read the Turkish Statistical Law consult <http://www.turkstat.gov.tr/UstMenu.do?metod=tuikKanun>. To find out about the current Strategic Plan, consult <http://www.turkstat.gov.tr/stratejik_plan/str2007.pdf>.

to previous data and the recently revised GDP estimates destroyed our hopeful expectations.

We found no equivalent table to NIPA or to the Integrated Economic Accounts table on the TurkStat website. We found no disposable income time series. We found only a «GDP by Expenditure table». The main reason, we believe, for such a situation is that TurkStat is at the beginning of its renewal process. Thus, not all tables are available.

The totals of final demand components in this last table are not equal to the column total of the final demand component of the input-output table. Only the total of final consumption expenditure, the total of gross capital formation, the total of exports, and the total of imports are comparable. The numbers are not exactly the same in the two tables. Therefore, for our purpose we considered taking into account the growth rate of the series even if the total was not exactly the same in the input-output table. When these lines were written there was no idea of the reason for these differences. We decided to use the 2002 Input-output table and GDP by Expenditure because they were homogeneous in theory, in the sense of ESA 95, even though the numbers were not exactly the same.

2.2 GDP by Expenditure

Table 1 represents a view of the content of the file ExpendituresGDP_Cur98.xls[6] as it appears in MS Excel. Here data are extracted and rearranged for the year 2002 only .

Table 1. Identities inside the ExpendituresGDP_Cur98.xls file (2002, 1000 YTL).

Gross Domestic Product	gdpaea	=	350 476 089
Final Consumption Expenditure of Resident Households	fcerhh	+ =	238399083
Final Consumption Expenditure of Resident and Non Resident Households on the economic territory	fcernrhhet	+	259441149
Final Consumption Expenditure of Non Resident Households on the economic territory	fcenrhhet	-	23886509
Final Consumption Expenditure of Resident Households in the Rest of the World	fcerhhrow	+	2844442
Government Final Consumption Expenditure gfce)	gfce	+ =	44615308
Compensation of Employees	gfcece	+	26533445
Purchases in Goods and Services	gfcepigas	+	18081863

[6] ExpendituresGDP_Cur98.xls is the Excel file containing the data from TurkStat.

Gross Fixed Capital Formation	gfcf	+	= 58601768
Public Sector	pubs		+ 15211265
Machinery-Equipment	pubsme		4353696
Construction	pubc		10857569
Private Sector	pris		+ 43390442
Machinery-Equipment	prime		25745309
Construction	pric		17645133
Changes in stock	cis	+	3131331
Exports of Goods and Services	expgs	+	88380641
Imports of Goods and Services	impgs	-	82651981

From Table 1, we can write:

gdp = fcerhh +gfce + gfcf + cis + expgs – impgs
With fcerhh = fcernrhhet – fcenrhhet + fcerhhrow
gfce = gfcece +gfcepigas
gfcf = pubs + pris
With pubs = pubsme + pubsc
pris = prisme + prisc

The source table contains annual and quarterly data for 1998 to 2007. In this paper, we take into account the annual data only. The next step is to import the data into a G bank.

2.3 2002 Input-Output table

On the TurkStat website, we did not find any instructive information on the 2002 Input-Output table. Generally, for all other tables, there were some files which described them. This was not the case this time. A recently published book[7] on Use and Supply Tables and the 2002 Input-Output Table were to make up for this lack of documentation.

A condensed skeleton version of the 2002 Input-Output Table, with the flow matrix FM reduced to two rows and two columns is shown in Table 2.

[7] Turkish Statistical Institute (2008), *The use-supply and input-output tables 2002*, Turkish Statistical Institute.

Table 2. A skeleton structure of 2002 Input-output table.

	FM		totr	fcehh	fcenpish	fceg	fce	gfcf	civ	cii	ciiv	gcf	expfob	fubp	tubp
totc															
tlsop															
ticupp															
coe															
ontop															
otop															
osop															
cofc															
osn															
osg															
vaabp															
oabp															
impcif															
sabp															

The acronyms used in the table are explained on the following pages, (see, Vam.cfg file below). The two lines are important: totc (total intermediate consumption) and ticupp (total intermediate consumption/use at purchasers' prices), because we need them to compute GDP by Expenditure at purchaser's prices as described in ESA 95.

3. *How to create Vam.cfg file and Identities?*

In this section, we give a list of all the identities or relations available from an Input-Output Table. This is essential because we want to show how to use this information to build a Vam configuration file. What is also emphasised is the importance of the availability of data in the definition of the structure of the model. Though TINYTURK is not a very complex model, we will still try to explain what must be done when a person wants to build a model. A Vam configuration file is a text file. Therefore, if it becomes necessary it can be modified at any moment of the building process.

What should the matrices and vectors insert or declare in a Vam.Cfg file? To answer to this question, we have to think of the computations to make in the model and of the data to show in graphics and tables. It is not necessary to insert all the rows or all the columns constituting a published Input-Output table in a Vam.cfg file. However, for computation we need some matrices and vectors which are not in the Input-Output table. Tables or graphs also need some specific vectors. Once a completed Vam.cfg file is properly prepared, then the model can be used.

3.1 Identities and relations in the Vam.cfg file

A Vam.cfg file can be easily generated with a text editor. However, to manage its contents is a process which requires some knowledge about how the different programs make use of it and of the structure of the model. For example to run the model with fixes on vectors and matrices, we have to run Fixer. Moreover, «to use the Fixer program, *it is essential that the model's Vam.cfg file should have a vector called "fix"* with enough rows to allow for each fix»[8]. In this section, we want to list all vectors and matrices, which must be inserted in the Vam.cfg.

An Input-Output table is not just a lot of cells with numbers. Each cell has a connection with the others. The connection in the same row or in the same column has an economic sense. In addition, relations and identities link cells in rows and columns. In the next section, we want to list these relations. We will try to define the vectors and matrices needed to perform such computations.

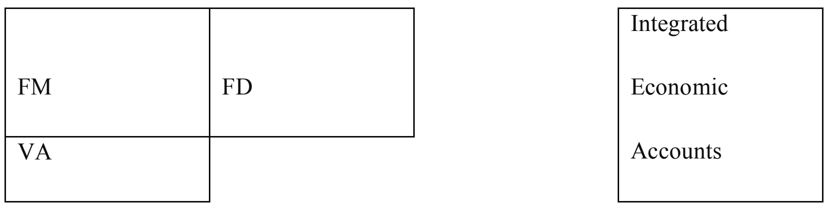
We will first define the relations of intermediate consumption, and then the relations of final demand and relations for value added. In the following, represents a row, and represents a column. The range for i in our input-output table is from 1 to 59. The range for j is also from 1 to 59. In addition, we assume we are writing a Vam.cfg file for an Inforum model. This model uses Input-Output tables and Integrated Economic Accounts tables[9] as required by ESA 95. For this reason, we have

[8] *The Craft of Economic Modeling*, Part III, pp. 83.

[9] The Integrated Economic Accounts are the equivalent in SNA 93 and in ESA 95 of the Nipa. In *The Craft of Economic Modeling*, Clopper Almon uses Nipa.

to use some matrices, vectors and time series, which are necessary in a traditional Input-Output model. In this assumed case, we can see the contents of the Vam.Cfg file, which covers not only the Input-Output table but also the structure and the use of the model itself. The general structure for an Inforum model is presented in Figure 1.

Figure 1. General structure of an Inforum model.



3.2 Identities and relations from the Intermediate consumption matrix (FM)

In a TINY model the relationships between matrices, vectors, and series are established by bridge matrices. Here we define five basic identities and relations which form the basis of TINYTURK.

Total of intermediate consumption by columns

$$(1) \qquad ictotc_j = \sum_{i=1}^{59} FM_{ij}$$

Total of intermediate consumption by rows

$$(2) \qquad ictotr_i = \sum_{j=1}^{59} FM_{ij}$$

Total of intermediate consumption

$$(3) \qquad ictot = \sum_{j=1}^{59} ictotc_j = \sum_{i=1}^{59} ictotr_i$$

Technical coefficient

$$(4) \qquad a_{ij} = \frac{ic_{ij}}{oabp_j}$$

From the point of view of matrix writing:

$$(5) \qquad AM = \begin{bmatrix} a_{1,1} & \cdots & a_{1,59} \\ \vdots & \ddots & \vdots \\ a_{59,1} & \cdots & a_{59,59} \end{bmatrix}$$

For the Vam.cfg file, we need to describe FM, AM as a matrix; we also have to describe ictotc as a vector. To compute AM we also need the vector oabp.

3.3 Identities and relations obtained by summation of rows (Final demand (FD))

In the second quadrant of the Inforum model structure, the Final demand quadrant, all the elements with a subscript *i* are elements of vectors. They have to be inserted in the VAM.cfg file. All the elements with another subscript are time series. Therefore, they go to the ws bank as an observation of the time series. Here only a few identities defined in the TINYTURK model are listed:

(6) $$fcenpish_{tot} = \sum_{i=1}^{59} fcenpish_i$$

(7) $$fceg_{tot} = \sum_{i=1}^{59} fceg_i$$

(8) $$fce_i = fcehh_i + fcenpish_i + fceg_i$$

(9) $$fce_{tot} = \sum_{i=1}^{59} fce_i$$

(10) $$fcehh_{totapp} = fcehh_{tot} + fcehh_{tlsopfd}$$

3.4 Identities obtained by summation of the columns (summation on j) (VA)

In this section we list some of the identities that can be formed within the Valued added matrix (VA). The rules defined above apply here too except that the «j» replaces the «i».

(11) $$tlsopic_{tot} = \sum_{j=1}^{59} tlsopic_j$$

(12) $$ticapp_j = tot_j + tlsopic_j$$

(13) $$ticapp_{tot} = \sum_{j=1}^{59} ticapp_j$$

(14) $$vaabp_j = coe_j + ontop_j + otop_j + osop_j + cofc_j + osn_j$$

(15) $$vaabp_{tot} = \sum_{j=1}^{59} coe_j + ontop_j + otop_j + osop_j + cofc_j + osn_j$$

(16) $$oabp_j = ticapp_j + vaabp_j$$

3.5 Other identities

There are two other extremely important identities. The first is the Input-Output table and the second is the set of three identities defined for the computation of GDP. These are explained by the following equations.

Input-output table

(17) $$sabp_j - tuabp_i = 0 \; for \; j = i$$

In the SNA 93 or ESA 95, GDP has three different expressions, each of which assigned a different name and represented by a different equation. Therefore, it would be possible to compare the results obtained for the three computations. Normally, they should be equal. It can be seen that they all used the results of the earlier computations in this paper.

i. GDP using the Product Approach

(18) $$gdpbpa = vaabp_{tot} + tuabp_{tlsop}$$

ii. GDP using the Expenditure Approach

(19) $$gdpbea = fce_{tot} + gcf_{tot} + expcob_{tot} - impcif_{tot}$$

iii. GDP using the Income Approach

(20) $$gdpbia = coe_{tot} + otop_{tot} + osop_{tot} + cofc_{tot} + osn_{tot} + tuabp_{tlsop}$$

4. Importing data into G and Vam banks

In this section, we first describe how to prepare and create a Vam.cfg file and then how to import data from MS Excel files into G and Vam banks. The content of this section could be used for building other models as well. Now, we know where our data are and how they are organized. We have to import them into G and Vam banks. To do so, we must determine which matrices, vectors and time series to use in the model. However, we first have to give a name to all the matrices, vectors and time series.

4.1 Names of matrices, vectors, and time series

G needs a name for each matrix, vector, and time series. It also requires some specific rules to build these names. We will give two examples of these rules, one for the G bank, and the other for the Vam file. In the G Help file «22. Forming variables», the following rule is set for the G bank: «Variable names must begin with a letter and may contain up to 32 letters, digits, or the '$' or '_'characters. Do not use a digit as the first character»

In the G Help file «45. The Vam Configuration File», we find the following rule for the Vam file: «Names of vectors may contain up to 16 letters or numbers and may contain the underscore mark, "_". They must not, however, end in a number. This restriction is necessary because it is sometimes necessary to use the sector number as a suffix to the vector name …»

As mentioned in the G Help file «45. Vam Configuration file», the names of all types must be «sufficient reminder». When we read the name of a matrix, a vector, or a time series, we should know at once what this name represents. To chose a name, an acronym based on the title of the matrix, vector, or time series is an easy rule. For example, «Gross domestic product» becomes gdp, «Taxes less subsidies on products» tlsop, and so on. Generally, in G usage, the matrix in an upper case letter is another rule.

It is easy to define the acronyms of the time series in the ExpenditureGDP_Cur98.xls file.The title of the time series is in the header of each column, we chose the first letter of each word of the title. For the title, «Final Consumption Expenditure of Resident Households», the acronym is fcerhh. It must also be added that G is case-sensitive: Q is not the same as q.

To create the name of the Intermediate consumption matrix, we can use the title «Flow matrix» and so the acronym is FM. For the coefficient matrix, we call it AM, in relation to its theoretical naming. Of course, there are exceptions to the rules as we see. However, these exceptions originate from Input Output theory or professional conventions.

4.2 Preparing a Vam.cfg file

The Vam.cfg file is a very important file in the process of model building with G and Interdyme. Understanding its content and its use is a key factor for mastering use of the G software family. In this section, we will demonstrate its importance and show how to build it. In G/Interdyme matrices and vectors are stored in a Vam file. To create a Vam file we need a configuration file. The Vam configuration file does not only contain information on the vectors and matrices we have to import but it also contains information on the vectors and matrices we want to use in the computation of the model.

Since a Vam configuration file is a text file, it can always be modified as needed in matrices and vectors. The only constraint is to re-run the file containing the G statements to create the Vam file of the model. The structure of a Vam configuration file is quite simple. It begins with a line, which defines the first year and the last year of the range of the time series of matrices and vectors.

In TINYTurk, 1998 represents the first year of data. The choice of 1998 finds its origin in the first year of the time series available in the MS Excel file ExpendituresGDP_bp.xls. Thus, it was convenient to run TINYTurk from this date. The end date represents in general a date in the distant future. The modeler could see the consequences on his/her choice over the period he/she needs to forecast or simulate.

The Vam.cfg file for TINYTURK is shown in Box 1 in the Appenix. In this file the character «#» defines a comment. The lines in italics represent totals of rows or totals of columns. The lines in bold and in italics represent the matrices or the vectors that the model needs. The normal line is the minimum information imported from the MS Excel file IO2002_BP.xls

To create an empty Vam file for TINYTURK, the following statements are typed into G:

```
Vamcreate vam.cfg hist
Vam hist b
Dvam b
```

The item «46. Creating, Assigning, Defaulting, and Closing a Vam File» of G Help gives all the details about these three lines.

The three lines run in G have created an empty Vam file. The Vam file created must now be filled with the data contained in the two files previously described:

- GDP by Expenditure;
- 2002 Input-Output Table.

4.3 From MS Excel files into Vam and G banks

The best way to find out about management of an MS Excel file into G is to look carefully at the item «66. How To Read and Write in Excel Format with G» of the G help. Ron Horst introduced the «xl» commands in G in 2006[10].

[10] Ron Horst Inforum world conference G New Features.

All the G commands used to work with MS Excel files begin with the word «xl». After «xl», another word indicates the operation to be performed. Open, read, write, close, workbook, worksheet, close, exit, and several others. Box 2 in the Appendix shows how the data from GDP by Expenditure file are read into G.

In Box 2, we have written some examples of lines from G Help, which open the workbook, open the worksheet 1 in the collection of worksheets and read the C column in it. Not all the lines of C column are read, only the one in the first list of the Do loop 3, 8, 13, etc. The second list of topics contains the date for the data of the selected lines of the C column. Therefore, C3 contains the observations for 1998; C8 contains the observations for 1999 and so on. This is the result of the «m» at the end of the do lists. Note that the data is read at step five since the original data comes in quarters as well as annual totals.

The final step in this section is how to read the 2002 Input-output table into G. To import the matrix, vectors and series to G from IOT2002_BP.xls, we used the same approach adopted in the previous paragraph. We have to import the matrix, vectors and time series defined in Table 3 and then compute all the identities we need.

Table 3. List of Matrix and vectors contained in 2002 Input-Output table.

Name	Type	Location in the worksheet
FM	Matrix	D11:BJ69
Fcehh	Vector	BL11:BL69
Fcenpish	Vector	BM11:BM69
Fcegov	Vector	BN11:BN69
Gfcf	Vector	BP11:BP69
Civ	Vector	BQ11:BQ69
Cii	Vector	BR11:BR69
Expfob	Vector	BU11:BU69
Tlsop	Vector	D71:BJ71
compemp	Vector	D73:BJ73
Ontop	Vector	D74:BJ74
Otop	Vector	D75:BJ75
Osop	Vector	D76:BJ76
Cofc	Vector	D77:BJ77
Osn	Vector	D78:BJ78
Impcif	Vector	D82:BJ82

The codes required to read all the data referred to in Table 3 into a Vam bank in G are quite long and cannot be repeated here[11].

[11] The codes reading the vectors and matrices into G are available from the authors upon request.

5. *A Tiny model for Turkey*

This section shows a list of commands (or codes) required to build and run the TINYTURK model. We have not shown all the G statements needed to create Vam and G banks. Instead, a file named TurkTiny_Data.add[12] was added, which contains all the files and statements to build the data banks. Finally, we merged all the different files written to run the model into a file to graph the results and to create tables.

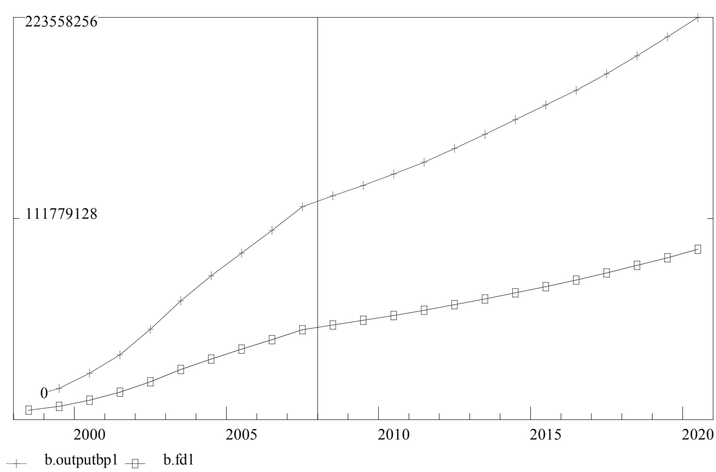
The code of TINYTURK is presented in Box 3 in the Appendix. Some figures and graphs obtained from the solution of the model are presented briefly.

5.1 Graphs

In the G family software, we can look at the results of the model by drawing graphs or by creating tables. It is then possible to view them on the screen or to build documents with preferred text processors or preferred presentation software. This section shows only two sample graphs for the first sector of the Input-output table, Agriculture, hunting, and related services. The next section shows an example for making tables.

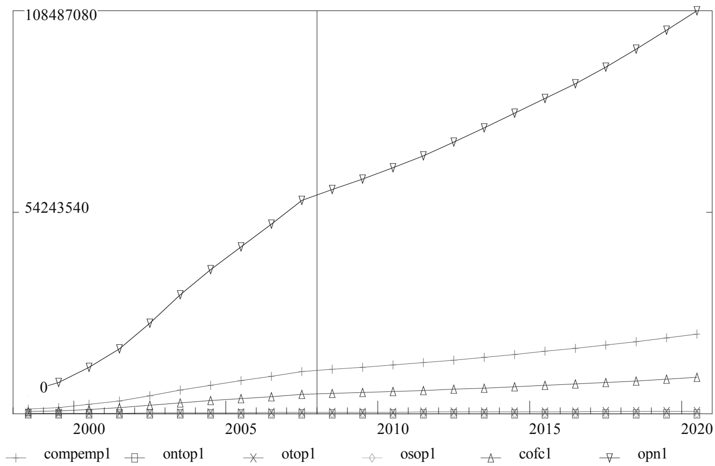
G7 contains many graphs commands. For a good descriptions of G graphs consult the G help file «*29. Drawing Graphs*». Figure 2 shows the graph for Agriculture, hunting, and related services' output and final demand figures. Figure 3 shows the components of value added for the same sector.

Figure 2. Output and final demand in the first Input-output sector (Agriculture).



[12] The contents of TurkTiny_Data.add is available from the authors upon request.

Figure 3. Components of value added in the first Input-output sector (Agriculture).



The striking feature of Figure 6 is that the Compensation of employees (wages) component of the Agricultural sector (compemp1) in Turkey is much less than Net operating surplus (opn1). This is the result of a strict (but «nonsensical») statistical convention which classifies all small and medium size farmers as non-wage income earners. Consequently the result comes out as if Turkish farms were capital intensive which they are not. Non-wage or self employed labor income is part of operating surplus by definition, but not part of wage income.

5.2 Tables

In this section, we do not explain how to create all the files to generate the tables of time series, vectors, and matrices. For further information, the reader may refer to the Tiny model for a short description, to the G help as usual and to the Compare.pdf file in the doc directory of the PDG directory. In Table 4 we have shown the output figures only for the first four sectors.

6. Conclusions

When we began this work, we did so with much enthusiasm but also with disappointment. We were ready to build a model but there was not enough data to do so, even disposable personal income figures did not exist. During the preparation of this paper, we had many discussions

Table 4. TURKTiny G-ONLY MODEL, Illustrative forecast.

	1998	2000	2002	2005	2010	2015	2020	98–02	02–05	05–10	10–15	15–20
1 Agriculture, hunting and related services	12324121.0	25737942.0	49988560.0	92324752.0	136279200.0	174658848.0	223558256.0	35.0	20.5	7.8	5.0	4.9
2 Forestry, logging and related services	274607.3	574811.9	1112617.8	2095960.8	2823632.5	3815814.0	4954040.0	35.0	21.1	6.0	6.0	5.2
3 Fish and other fishing products; services inci	75608.0	415340.6	845745.4	1607460.1	2417023.2	3104226.5	3983366.0	39.3	21.4	8.2	5.0	5.0
4 Coal and lignite; peat	338265.2	872071.9	1823094.5	3508578.0	4634197.0	6321768.5	8256005.5	42.1	21.8	5.6	6.2	5.3

with TurkStat, and discovered that the entire problem from a statistical point of view is one of integration with the European Union.

This exercise is very good practice for beginners for becoming a model builder; and is also a very good way of focusing on practice and knowledge for advanced model builders.

It looks as if it is not yet possible to build a complete Inforum model for Turkey, but it will be possible to do so in the near future. This paper hopes to add to Almon's work, with a European touch.

Appendix

Box 1. Vam.cfg file for TINYTURK.

```
#-----------------------------------------------------------------------------
#   Vam.cfg file for the Input-Output Table 2002 - Basic Prices - Current
#-----------------------------------------------------------------------------
1998 2020
#   Matrices
FM      59 59 0 sectors02.ttl sectors02.ttl # Intermediate consumption matrix
AM      59 59 0 sectors02.ttl sectors02.ttl # Intermediate coefficient matrix
LINV    59 59 0 sectors02.ttl sectors02.ttl # Leontief Inverse
#   Vectors
#   Final Demand
totr      59  1 0 sectors02.ttl  # 60 Total Intermediate consumption row
fcehh     59  1 0 sectors02.ttl  # 61 Final consumption expend.  by households
fcenpish  59  1 0 sectors02.ttl  # 62 Final consumption expenditure by
                                 # non-profit organizations serving households
fcegov    59  1 0 sectors02.ttl  # 63 Final consumption expenditure
                                 #  by government
fce       59  1 0 sectors02.ttl  # 64 Final consumption expenditure
gfcf      59  1 0 sectors02.ttl  # 65 Gross fixed capital formation
civ       59  1 0 sectors02.ttl  # 66 Changes in valuables
cii       59  1 0 sectors02.ttl  # 67 Changes in inventories
ciiv      59  1 0 sectors02.ttl  # 68 Changes in inventories and valuables
gcf       59  1 0 sectors02.ttl  # 69 Gross capital formation
expfob    59  1 0 sectors02.ttl  # 70 Exports, fob
fuabp     59  1 0 sectors02.ttl  # 71 Final uses at basic prices
tuabp     59  1 0 sectors02.ttl  # 72 Total use at basic prices
#   Value Added Components
compemp   59  1 0 sectors02.ttl  # 63 Compensation of employees
ontop     59  1 0 sectors02.ttl  # 64 Other net taxes on production
otop      59  1 0 sectors02.ttl  # 65 Other taxes on production
osop      59  1 0 sectors02.ttl  # 66 Other subsidies on production
```

```
cofc      59  1 0 sectors02.ttl  # 67 Consumption of fixed capital
opn       59  1 0 sectors02.ttl  # 68 Operating surplus, net
opg       59  1 0 sectors02.ttl  # 69 Operating surplus, gross
vaabp     59  1 0 sectors02.ttl  # 70 Value added at basic prices
outputbp  59  1 0 sectors02.ttl  # 71 Output at basic prices
impcif    59  1 0 sectors02.ttl  # 72 Imports, cif
supplyabp 59  1 0 sectors02.ttl  # 73 Supply at basic prices
#
totc      59  1 0 sectors02.ttl  # 60 Total
tlsop     59  1 0 sectors02.ttl  # 61 Taxes less subsidies on products
totic     59  1 0 sectors02.ttl  # 62 Total intermediate consumption/
                 #  Final use at purchasers' prices
#
totcfd    13  1 0 sectors0213.ttl # 60 Total
tlsopfd   13  1 0 sectors0213.ttl # 61 Taxes less subsidies on products
toticfd   13  1 0 sectors0213.ttl # 62 Total intermediate consumption/
                 #  Final use at purchasers' prices
#  Final demand – This vector does not exist in the 2002 Input Output table.
fd        59  1 0 sectors.ttl   #  Final demand
#  Ratios
fcehhr    59  1 0 sectors02.ttl  # 61 Final consumption expenditure by households
fcenpishr 59  1 0 sectors02.ttl  # 62 Final consumption expenditure by non-profit
                 #  organizations serving households NPISH)
fcegovr   59  1 0 sectors02.ttl  # 63 Final consumption expenditure by government
fcer      59  1 0 sectors02.ttl  # 64 Final consumption expenditure
gfcfr     59  1 0 sectors02.ttl  # 65 Gross fixed capital formation
civr      59  1 0 sectors02.ttl  # 66 Changes in valuables
ciir      59  1 0 sectors02.ttl  # 67 Changes in inventories
ciivr     59  1 0 sectors02.ttl  # 68 Changes in inventories and valuables
gcfr      59  1 0 sectors02.ttl  # 69 Gross capital formation
exofobr   59  1 0 sectors02.ttl  # 70 Exports, fob
impcifr   59  1 0 sectors02.ttl  # 72 Imports, cif
#  Shares
compemps  59  1 0 sectors02.ttl  # 63 Compensation of employees / outputbp
ontops    59  1 0 sectors02.ttl  # 64 Other net taxes on production / outputbp
otops     59  1 0 sectors02.ttl  # 65 Other taxes on production / outputbp
osops     59  1 0 sectors02.ttl  # 66 Other subsidies on production / outputbp
cofcs     59  1 0 sectors02.ttl  # 67 Consumption of fixed capital / outputbp
opns      59  1 0 sectors02.ttl  # 68 Operating surplus, net / outputbp
opgs      59  1 0 sectors02.ttl  # 69 Operating surplus, gross / outputbp
#   Workspace
X         59  1 0 sectors02.ttl  #  Workspace
Y         59  1 0 sectors02.ttl  #  Workspace
```

Box 2. G code to read the content of the worksheet.

```
xl open \modeles\turkey\data_g\ExpendituresGDP_cur98.xls
do {
xl open worksheet 1
xl read C %1 down fce %2 %2
  } (3 8 13 18 23 28 33 38 43 48) (1998-2007) m
type fce 1998 2007
```

Box 3. The code of TINYTURK.

```
#   TINYTURK - A TINY model for Turkey
#   Bring in dat
add TurkTiny_Data.add1
#   Year of the IOT
fdates 2002 2002
#   Compute the value of the row sum of FM and store
#   the result in the vector outputbp
getsum FM r outputbp
#   Add to outputbp the total of Final demand
vc outputbp = outputbp + fce + gcf + expfob - impcif
#   Copy the content of the Flow matrix to
#  the coefficient matrix
mcopy b.AM b.FM
#   Compute the technical coefficient
coef AM outputbp
-------------------------------------
#   Creation of series needed to forecast Final demand components
fdates 1998 2020
#  Creation of a time trend and growth rate series
f time = @cum(time,one,0)
f g03  = @exp(.05*(time-10))
f waves = g03 + 0.3 * @sin(time-9)
#  "Forecasts" of the Final demand components
fdates 2007 2020
index 2007 g03  fcehh
index 2007 g03  fcenpish
index 2007 g03  fcegov
```

References

Almon C. (2008). The Craft of economic modeling, <http://inforumweb.umd.edu/papers/TheCraft.html>.

Inforum (2008a), Compare, <http://inforumweb.umd.edu/...PDG/DOC >.
Inforum (2008b). G User guide and reference, <http://inforumweb.umd.edu/papers/publishedwork/books/craft3.pdf>.
Horst R. (2006). How to read and write in Excel format with G. Paper delivered at 14th Infroum World Conference, 11-15 September, 2006, Taunkirchen, Austria.
SNA (1993). About the System of National Accounts 1993, <http://unstats.un.org/unsd/sna1993/>.
OECD (2006). Understanding National Accounts 2006, <http://www.oecd.org/dataoecd/37/12/38451313.pdf>, or <http://puck.sourceoecd.org/vl=3135196/cl=35/nw=1/rpsv/una/>.
ESA 95 Web Site, <http://circa.europa.eu/irc/dsis/nfaccount/info/data/esa95/en/titelen.htm>.
TurkStat Web Site, <http://www.turkstat.gov.tr/Start.do>.

THE ROLE OF INNOVATION IN INCREASING EFFICIENCY IN THE POLISH ECONOMY: A SECTORAL VIEW

Łucja Tomaszewicz, Iwona Świeczewska
Department of Theory and Analyses of Economic Systems
University of Lodz

1. *Introduction*

The paper presents the results of an empirical investigation into the impact of innovation on changes in total factor productivity (TFP) in the Polish economy at the sectoral (industry) level, taking into account the effects of the inter-industry and inter-country diffusion of innovation. An attempt was made to answer the question to what extent the efficiency of Polish industries (as measured by TFP changes) is driven by their potential to innovate (as measured by the intensity of industry's R&D expenditure), and to what extent it is a result of the diffusion of innovation from other industries and from abroad.

The analysis was based on econometric models estimated using time-series of the cross-section data for the years 1993-2005, characterizing TFP growth rates in the Polish economy by NACE sections and – in the case of manufacturing – by divisions. To account for the effects of innovation, appropriate measures showing the potential benefits offered by the process of diffusion had to be constructed for each section/division. As regards domestic innovations, the measures were based on the input-output methodology, which assumes that the intermediate flows are carriers of innovation among industries. As far as diffusion from abroad is concerned, specific industry's imports, as well as foreign direct investments were assumed to be the carriers of innovation.

2. *Total factor productivity as a measure of efficiency*

Total factor productivity (TFP) is one of the measures that is used to assess economic efficiency in the context of broadly understood technical progress (Griliches 1995; Coe & Helpman 1995; Welfe 2001). It represents output per unit of combined production factors. Viewed dynamically, an increase in total factor productivity represents this part of output growth, which is not related to the growth of production factors.

Maurizio Grassini and Rossella Bardazzi (edited by), *Energy Policy and International Competitiveness*,
ISBN 978-88-6453-040-6 (print) ISBN 978-88-6453-043-7 (online)

Therefore, the rate of growth of TFP (*tfp_gr*) equals:

$$(1) \quad tfp\_gr_t = Y\_gr_t - \sum_{i=1}^{n} w_{it}(X_i\_gr_t)$$

where:

tfp_gr_t: rate of TFP growth in period *t;*
Y_gr_t: rate of output growth in period *t*;
X_gr_t: rate of growth of the i-th factor of production in period *t*;
W_{it}: weight of the i-th factor in output growth in period *t*.

The weights (W_i) are either the shares of the respective factors of production in output, or output elasticities in relation to the i-th production factor. Assuming the shares of production factors in output to be the weights, the rates of TFP growth can be assessed by means of the index methods (usually the Törnquist index is used – Griliches, Jorgenson 1967; Gullickson 1995). The other approach requires the use of a production function (usually the neoclassical Cobb-Douglas form with constant returns to scale is used – Welfe 2001; Tokarski Roszkowska & Gajewski 2005; Świeczewska 2007) where estimated (or calibrated) parameters are used to determine output elasticities in relation to each factor of production.

In this article, TFP estimation was based on the index methods (the Törnquist index). Gross output was assumed as a measure of production of each industry[1], thereby the intermediate inputs of raw materials were added to the list of production factors. The weights are the average shares of respective factors in gross output. Estimates of TFP growth rates for individual industries are presented in the table below:

Table 1. Average rates of TFP growth in Poland, 1993-2005 and sub-periods, by NACE section and division.

	1993-2005	1993-96	1997-99	2000-02	2003-05
			%		
TOTAL	1.4	1.5	1.3	1.8	2.2
Agriculture, hunting and forestry	1.4	0.1	0.9	0.5	4.4
Fishing	0.9	-3.6	2.7	6.2	2.3
Industry	2.0	3.0	2.1	1.2	1.3

[1] Estimates of the rate of TFP growth for the entire economy were based on the dynamics of value added, taking into account only the primary factors of production (i.e. employment and capital stock, the latter being measured by gross fixed assets).

Mining and quarrying	1.5	3.1	1.7	–0.3	–0.1
Manufacturing	2.1	3.1	2.5	1.2	1.3
manufacture of food products	1.3	1.9	2.0	0.6	1.2
manufacture of tobacco products	-1.2	–0.8	–4.4	1.3	1.4
manufacture of textiles	2.2	3.8	3.6	1.6	1.1
manufacture of wearing and fur products	1.7	4.8	1.2	-1.4	-1.5
manufacture of leather and leather products	0.3	4.9	0.3	-1.3	-2.6
manufacture of wood and wood products	0.6	0.1	0.0	0.3	0.7
manufacture of paper and paper products	1.8	0.8	4.7	0.9	0.8
publishing and printing	0.8	5.9	0.9	-3.1	-2.5
manufacture of coke and refined petroleum products	–0.1	3.2	-3.7	-3.0	-3.8
manufacture of chemicals and chemical products	1.5	1.3	2.0	0.7	1.3
manufacture of rubber and plastic products	2.9	3.0	5.4	1.0	2.0
manufacture of other non-metallic and other mineral products	4.5	3.7	3.8	8.5	2.8
manufacture of basic metals	0.9	1.8	1.2	1.3	0.5
manufacture of fabricated metals	3.6	3.6	3.3	3.9	3.5
manufacture of machinery and equipment	4.2	5.8	3.2	2.4	4.3
manufacture of office machinery and computers	10.1	17.3	15.0	2.7	9.4
manufacture of electrical equipment	2.9	3.2	3.9	3.2	3.9
manufacture of radio, television and communication equipment	5.1	12.7	3.6	–0.6	1.8
manufacture of medical, precision and optical instruments, watches and clocks	3.5	8.7	7.8	-2.6	2.3
manufacture of motor vehicles	2.4	2.4	0.7	2.7	2.8
manufacture of other transport equipment	0.6	–0.7	6.6	-2.8	–0.6
manufacture of furniture	1.7	3.3	1.1	1.5	2.2

recycling	-0.1	-2.1	5.0	-1.4	4.4
Electricity, gas distribution, water supply	0.6	0.6	-0.8	0.7	1.2
Construction	0.0	1.9	0.8	-1.7	0.1
Trade and repair	-1.6	-1.5	-3.1	-0.6	-0.1
Hotels and restaurants	0.5	1.2	1.9	-1.6	0.0
Transport, storage and communication	1.7	0.5	2.6	1.9	1.3
Financial intermediation	7.3	14.5	4.5	2.0	3.0
Operation of real estate and services delivered to firms	-0.2	0.4	-2.0	0.3	0.5
Public administration and defence	-2.4	-1.4	1.0	-8.4	1.6
Education	0.9	0.6	2.4	1.0	1.5
Health care and social security	0.9	1.1	-2.6	3.6	1.8
Other services, public utilities, social and individual services	-2.9	-5.3	-3.8	-1.0	0.1

Source: authors' calculations based on Central Statistical Office (CSO) data on gross output, intermediate use, fixed assets and employment, published in the CSO Statistical Yearbooks 1995-2006, and Statistical Yearbooks of Industry 1996-2006.

Examination of the above data led to the following conclusions.

- Average annual rates of TFP growth for the economy as a whole in the years 1993-2005 were around 1.4%, with the highest rate standing at 2.2% in the last two periods of the time-span analyzed (2003-2005). It seems, however, that the rates of growth for the last sub-period were substantially overestimated, possibly because of the overestimated TFP growth rate in agriculture (4.4% in the years 2003-2005), as a result of CSO's modified methodology for calculating employment in that sector, specifically, the rates of TFP growth in industry and services were significantly lower[2].

[2] The role of agriculture in the Polish economy is still significant. This sector contributes over 4% of GDP, its employment making up over 20% of the total number of employees in the country. The TFP growth rates were estimated based on the CSO data, according to which the number of employees in agriculture fell by over half between 2002 and 2003. In fact, it was not agricultural employment that decreased, but the methodology for its estimation was modified. Since 2003 that estimate excludes persons working on farms of less than 1 hectare, producing exclusively or mainly for their own needs. Thus, the share of agricultural employees in total employment decreased by over 10 percentage points from the level of 28% (in 2002), significantly increasing the rate of TFP growth.

- The rate of growth of TFP in the industry sector (including mining and quarrying, manufacturing and energy supply) over the time span of the sample was approximately 2% per annum, with the highest rates observed in the 1990s. The reason was the fast development in that sector driven by considerable investment activity in industry (the average annual rate of growth of investment outlays in the years 1993-1998 stood at 13.3%) as well as the increased inflow of foreign direct investment (the Polish Information and Foreign Investment Agency (PAIiIZ) estimated the average annual rate of FDI growth in industry at 50% between 1994-1998) [3]. The slowdown of the rate of economic growth observed after 1999 decelerated the TFP growth rates to 1.2% (in the years 2000-2002). The acceleration after 2003 slightly increased the growth rate of TFP to 1.3% in the period 2003-2005.
- The manufacturing sector, accounting for over 80% of industry, showed a similar dynamics. The rate of growth of TFP for other industrial sectors, i.e. mining and quarrying, and the supply of electricity, gas and water, was significantly lower, and in some sub-periods clearly negative (meaning that output grew slower than the factor inputs did).
- Among the manufacturing industries, the highest TFP growth rates were found for high- and medium-technology industries, such as the manufacture of office machinery and computers (average annual rate of TFP growth was 10.1%, the highest in the 1990s), the manufacture of radio, television and communication equipment (5.1% annually, with the highest in the years 1993-1996), the manufacture of machinery and equipment (4.2% annually), and the manufacture of medical, precision and optical instruments, watches and clocks (3.5% annually). The above industries attracted foreign investors, particularly in the years 1993-1996 (according to PAIiIZ, these industries accounted for 15%-26% of total FDI inflow to industry as a whole). Moreover, in the case of the manufacture of machinery and equipment, relatively high outlays on innovation activity (compared with other manufacturing industries) could be observed. The manufacture of «other non-metallic» products is also noteworthy, with its annual average TFP growth rate of 4.5%, the highest rates being observed in 2000-2002. In this case, the efficiency increase can be attributed to the intensified inflow of FDI from 1998.
- In other manufacturing industries the rates of TFP growth never reached 4%, the lowest (or even negative) rates appearing in the material- and labour-intensive branches, even though some of them allocated substantial amounts to innovation activity (the manufacture of food products and beverages, the manufacture of paper and paper products).

[3] The PAIiIZ data only regard FDI values over USD 1 million.

- The rates of TFP growth in the service sector were considerably lower than in the industrial branches, partly due to the specific character of services themselves. The highest rate was reported for financial intermediation (7.3% over the time span investigated, the highest rates were found for the years 1993-1996) and for transport, storage and communication services (1.7% annually, the highest in the years 1997-1999). The high efficiency of those sectors may have resulted from substantial FDI inflows, as well as active investment processes in the 1990s.

3. The impact of innovation on the efficiency of the economy: methodological aspects

The basic tool used in assessing the impact of innovation impact on an economy's efficiency is an extended production function (usually of the Cobb-Douglas type) that includes, in addition to the primary factors of production, also a stock of knowledge capital, usually represented by cumulative R&D expenditure (Clark, Griliches, 1982; Griliches, 1995). This relationship can be written as:

$$(2) \quad Y_t = TFP_t \cdot F\left(RDC_t, K_t, L_t\right)$$

where:

Y_t: volume of output in period t;
TFP_t: total factor productivity in period t;
RDC_t: volume of cumulative R&D expenditure in period t;
K_t: capital stock;
L_t: labour.

Differentiating relationship (2) over time time and dividing both its sides by allows us, after simple transformations, to determine the rate of TFP growth as a function of the growth rate of cumulative R&D expenditure (RDC_gr_t):

$$(3) \quad TFP\_gr_t = \lambda + \gamma \cdot RDC\_gr_t$$

or, alternatively (assuming that the rate of depreciation of cumulative R&D expenditures is close to zero), as a function of intensity of R&D outlays (represented by the share of R&D expenditures in output):

$$(4) \quad TFP\_gr_t = \lambda + \mu \frac{RD_t}{Y_t}$$

The above relationship is the starting point for analyses seeking to explain the influence of innovations on the efficiency of the Polish economy.

One of the most important features of innovations is their ability to spread among economic agents. The diffusion process can be triggered by purchases of various products (intermediate, investment or consumption goods), new technologies (also licences and the rights to apply them), as well as via the introduction of similar technological solutions based on common knowledge (Griliches 1979). It can take place both within an economy and at the inter-country level. For empirical studies to account for innovation diffusion, a measure must be developed, representing the benefits offered by the process. It is usually assumed that the scale of these benefits is proportional to the stock of knowledge (usually measured using current and/or cumulative R&D expenditures) held in all possible sources of diffusion, i.e.:

$$(5) \quad RDspill_j = \sum_{i \neq j} v_{ij} RD_i$$

where:

$RDspill_j$: R&D effects in industry j, stemming from the diffusion of innovation from source i (industry i);

RD_i: R&D expenditures of the innovation-transferring sources;

V_{ij}: proportionality coefficients (weights).

This paper assumes that the benefits from diffusion processes reaped by a given industry are proportional to the intensity of R&D outlays (i.e. to the ratio of R&D outlays to gross output) in branches transferring innovations, i.e.:

$$(6) \quad \overline{RDspill_j} = \sum_{i \neq j} v_{ij} \frac{RD_i}{Y_i}$$

where

Y_i: gross output of the industry i.

If the transfer of innovations is based on formal transactions between industries (and thus applies to the embodied innovations), the weights V_{ij} are based on transaction values. Such transactions may involve investment goods, as well as intermediate goods and patents. When the inter-sectoral diffusion of innovation within an economy is explored, it is essential to have access to data on the flows of investment goods between suppliers and purchasers (Terleckyj 1974, Sveikauskas 1981; Sterlacchini 1989), and data on the flows of raw materials (Brown, Conrad 1967; Wolff & Nadiri 1993; Wolff 1997; Dietzenbacher 2000). As far as the inter-country transfer of innovations is concerned, a crucial role is played by imports from particular economies (especially by the investment imports – Coe, Helpman 1995), foreign direct investment (Lichtenberg, van Pottelsberghe de la Potterie 1996), and the flows of foreign patents (Jaffe, Trajtenberg 1999). As for the common knowledge (diffusion of intangible innovative assets), the volume of transfer depends on the proximity of technological links between suppliers and recipients. This technological proximity can arise, for instance, from the similarities of innovation activities (Goto, Suzuki 1989; Jaffe 1986; Verspagen 1997).

In this paper, we attempt to estimate the benefits of the inter-industry diffusion of innovation via intermediate inputs. The flows of investment goods could not be treated as the carriers of innovation embodied in the products of the respective industries, because matrices of the flows of investment goods were not available. The analysis used an input-output approach. In the simplest case it was assumed that the innovations a given industry produces and transfers to other industries were commensurate with the intermediate flows, represented by input-output coefficients (direct input coefficients, usually denoted by a_{ij}). These coefficients show the values of materials originating from industry i that are necessary to produce a unit of gross output in industry j. They were treated as weights in determining a given industry's benefits from the processes of inter-sectoral diffusion.

The input-output models aim at following indirect links between industries. They are characterized by means of multipliers (elements of the «Leontief inverse» matrix $(I\text{-}A)^{-1}$, where $A = [a_{ij}]$ is the matrix of direct input coefficients). This feature was indicated by Momigliano and Siniscalco (1982), who proposed using Leontief inverse components as the weights measuring the advantages of innovation diffusion.

Dietzenbacher (2000) proposed a more developed methodology of investigating the inter-sectoral diffusion of innovation in the input-output framework – that also makes use of the input-output multipliers. An unquestionable advantage of the Dietzenbacher method is that it distinguishes between process and product innovations. Theoretical considerations led Dietzenbacher to define the measures of impact of both process and product innovation diffusion. These measures were used, *inter alia*, as the weights in assessing benefits offered by the inter-industry diffusion of domestic innovations in the Polish economy (Świeczewska, Tomaszewicz 2007). However, they did not satisfactorily explain the TFP growth rates (by industry). Finally, the direct input coefficients a_{ij} were assumed as weights thereinafter.

Regarding the transfer of foreign innovations, it was assumed that their main carrier was imports coming to a given sector, as well as foreign direct investments. The appropriate weights – essential to identifying benefits from the transfer of innovations – were estimated using data on the import structure for the respective industrial branches (imports from selected OECD countries are concerned)[4]. Though being an important carrier, FDI in industrial branches was omitted because of the unavailability of open-accessible and comparable data at the level of NACE divisions[5]. Some approximate data obtained by the authors require evaluation and so they were not used in this study. For the service sector, the potential advantages of innovation transfer were approximated by FDI intensity in a given period (FDI inflow per unit of sector's gross output). Poland's six major trade partners in foreign trade (the most developed economies) were taken into account, i.e. Germany, France, the Netherlands, Italy, the UK and the USA.

Despite the unavailability of data on investment imports directed to particular industries, an attempt was made to account for this carrier of foreign innovations. Based on the import structures of industries supplying investment goods[6], potential advantages from the transfer of innovation embodied in such products were estimated for each of the industry divisions.

4. The impact of innovation on the efficiency of the economy – empirical results

The effect of innovations on the efficiency of the Polish economy was estimated using model (4), where the intensity of innovation outlays in each industry was broken down into the intensity of expenditures spent by the industry itself, benefits derived from the inter-sectoral diffusion of innovations with the flows of raw materials, and advantages arising from the diffusion of foreign innovations. Thus, model (4) takes the following form:

$$(7) \quad TFP\_gr_{jt} = \lambda + \mu_1 \frac{RD_{jt}}{Y_{jt}} + \mu_2 \overline{RDspill_{jt}}^{(domestic)} + \mu_2 \overline{RDspill_{jt}}^{(foreign)} + \varepsilon_{jt}$$

where:

TFP_gr_{jt} : rate of TFP growth in industry *j*, in period *t*;

[4] The relevant data are derived from the OECD Bilateral Trade Database (BTM). They show imports from different branches of industry abroad to individual industry branches in Poland.

[5] The main source of FDI data used in this study is PAIiIZ. However, in 2004 the Agency stopped publishing FDI figures by industry.

[6] That is industries such as the manufacture of machinery and equipment, manufacture of office machinery and computers, manufacture of electrical equipment, manufacture of radio, television and communication equipment.

$\frac{RD_{jt}}{Y_j}$: intensity of R&D expenditures made by industry j in period t;

$\overline{RDspill_{jt}}^{(domestic)}$: benefits of intersectoral innovation diffusion for industry j in period t;

$\overline{RDspill_{jt}}^{(foreign)}$: benefits of the diffusion of foreign innovations for industry j in period t;

ε_{jt} : error term.

Model (7) or more precisely its different variants, was estimated using time series of the cross-section data including 32 industries (NACE divisions for manufacturing, NACE sections elsewhere) for the following years: 1993-96, 1997-99, 2000-02, 2003-05. This averaging of annual data was applied because the TFP changes by industry showed strong fluctuations that reflect the demand-supply shocks rather than the actual changes in the efficiency of production. In all tested model variants, dummy variables were introduced for chosen industries and periods. The results are shown in Table 2.

Table 2. Estimation results for model (7).

Variables	Estimates (t-value in brackets)			
	I	II	III	IV
Constant	-0.07 (-1.32)	0.02 (0.64)	0.05 (0.92)	0.03 (0.91)
$\frac{RDexpend_{jt}}{Y_j}$	0.14 (1.92)*	0.14 (1.92)*	0.17 (1.81)*	0.17 (2.45)**
$\overline{RDspill_{jt}}^{(domestic)}$		0.39 (1.33)	0.40 (1.40)	
$\overline{RDspill_{jt}}^{(foreign)}$	0.18 (3.20)***	0.17 (3.06)***	0.29 (3.71)***	0.30 (3.88)***
Dummy for industries	Yes	yes	yes	yes
Dummy for periods	Yes	yes	yes	yes
R^2 adjusted	0.47	0.48	0.51	0.49
No. of observations	128			

Source: authors' calculations; * - statistically significant at the level of 0.1; ** - statistically significant at the level of 0.05; *** - statistically significant at the level of 0.01.

Channels of innovation diffusion by model variant: (I) – diffusion of foreign innovations via imports and FDI, (II) – domestic diffusion of innovations with the flows of raw materials, diffusion of foreign innovations via imports and FDI, (III) – domestic diffusion of innovations with the flows of raw materials, diffusion of foreign innovations via investment imports and FDI, (IV) - diffusion of foreign innovations via imports and FDI.

Estimation of model (7) parameters provides the following conclusions:

- Firstly, in all tested variants the parameters of the industry R&D outlays proved to be positive and statistically significant. Intensity of the domestic R&D outlays growing in a given industry by 1 p.p. increased the rate of TFP growth by 0.14-0.17 p.p. on average.
- Secondly, the effects of diffusion of foreign innovations were positive and statistically significant in all variants of the model, for both diffusion effected via imports (total and investment imports) and FDI. These results show that foreign innovation diffusion induces an increase in the rate of TFP growth standing at 0.17-0.30 p.p. on average, with the impact being obviously stronger for investment imports (machinery and equipment) acting as the channel for diffusion.
- Thirdly, the effects of domestic innovations spreading with the inter-industry flows of raw materials turned out to be positive, though not significant.

5. Conclusions

The study presented focused on the diffusion of innovation embodied in products, i.e. in the intermediate inputs in the case of domestic diffusion. However, it omitted the flows of investment goods, as well as another important carrier – the foreign direct investment in industries. In both cases, the reason was the unavailability of appropriate statistical data. The authors hope that the self-estimated data will throw some more light on the sources of innovation in the Polish economy. The investigation has so far pointed to the special importance of the foreign sources, given that the intensity of R&D expenditure increasing by 1 p.p. in countries which are major suppliers of imports to Poland improves the efficiency of the Polish economy more (the TFP growth rate increases by 0.17-0.30 p.p.) than an analogous growth of intensity of the domestic R&D expenditures (0.14-0.17 pp.) does. Apart from the aforementioned enhancement of the list of carriers of innovation diffusion (flows of investment goods, FDI by industry) and investigation into their role as efficiency boosters in Polish industries, the authors started to research applications of alternative methods enabling identification of the paths of inter-sectoral diffusion of innovations.

References

Coe D.T., Helpman E. (1995). International R&D Spillovers. *European Economic Review*, vol. 39.

Dietzenbacher E. (2000). Spillovers of Innovation Effects. *Journal of Policy Modelling*, vol. 22, pp. 27-42.

Goto A., Suzuki K. (1989). R&D Capital, Rate of Return of R&D Investment and Spillover of R&D in Japanese Manufacturing Firms. *Review of Economics and Statistics*, vol. 71, pp. 555-564.

Jaffe A.B. (1986). Technological Opportunity and Spillovers of R&D: Evidence from Firms' Patents, Profits and Market Value. *American Economic Review*, vol. 76, pp. 984-1001.

Jaffe A., Trajtenberg M. (1999). International Knowledge Flows: Evidence from Patent Citations. *Economics of Innovation and New Technology*, vol. 8, pp. 105-136.

Lichtenberg F.R., Van Pottelsberghe de la Potterie B. (1996). International R&D Spillovers: A Re-examination. NBER, Working Paper No. 5668.

Griliches Z. (1995). *Firm Productivity in Israeli Industry*, 1979–1988, *Journal of Econometrics*.

Griliches Z. (1967). Jorgenson D., The Explanation of Productivity Change. *Review of Economic Studies*, July.

Gullickson W. (1995). Measurement of Productivity Growth in U.S. Manufacturing. *Monthly Labor Review*,July.

Momigliano F., Siniscalco D. (1982). The Growth of Service Employment: A Reappraisal. BNML *Quarterly Review*, 142, pp. 296-306.

Sterlacchini A. (1989). R&D, Innovations and Total Factor Productivity Growth in British Manufacturing. *Applied Economics*, vol. 21, pp. 1549-1562.

Sveikauskas L. (1981). Technological Inputs and Multifactor Productivity Growth. *Review of Economics and Statistics*, vol. 68, pp. 275-282.

Świeczewska I. (2007). Łączna produktywność czynników produkcji. Ucieleśniony kapitał wiedzy (Total Factor Productivity. The Embodied Knowledge Capital). In: W. Welfe (ed.), *Gospodarka oparta na wiedzy (Knowledge-based economy)*, PWE, Warsaw.

Terleckyj N.E. (1974). *Effects of R&D on the Productivity Growth of Industries: An Exploratory Study*, National Planning Association, Washington D.C.

Tokarski T., Roszkowska S., P. Gajewski P. (2005). Regionalne zróżnicowanie łącznej produktywności czynników produkcji w Polsce (Regional Diversity of TFP in Poland). *Ekonomista*, n. 2.

Tomaszewicz Ł. (1994). *Metody analizy input-output (Methods of Input-Output Analysis)*, PWE, Warszawa.

Verspagen B. (1997). Measuring Intersectoral Technology Spillovers: Estimates from the European and US Patent Office Databases. *Economic Systems Research*, vol. 9, n. 1, pp. 47-65.

Welfe W. (ed.) (2001), *Ekonometryczny model wzrostu gospodarczego (Econometric Model of Economic growth)*, Wydawnictwo UŁ, Łódź.

Wolff E.N. (1997). Industrial Composition, Interindustry Effects and the U.S. Productivity Slowdown. *Review of Economics and Statistics*, vol. 65, pp. 268-277.

Wolff E.N., Nadiri M.I. (1993). Spillover Effects, Linkage Structure, and Research and Development. *Structural Change and Economic Dynamics*, vol. 4, pp. 315-331.

DATA, TOOLS AND METHODS

THE STATISTICAL ENVIRONMENT OF INFORUM MODELS. MAJOR CHANGES AHEAD

Josef Richter
University of Innsbruck[1]

1. Introduction

INFORUM modelling is dependent on the available statistical data. The nature of the data and the access to the data are limiting factors for all modelling activities.

Two major changes in the statistical environment will happen in the near future: one is the revision of all classification systems such as ISIC, NACE and CPA. This change with major implications on all time series has already started, although national accounts data and input-output tables in the new classification system will only be available in a few years. The other major change is the revision of the system of national accounts itself. The final decisions on the SNA 2008 will be taken this and next year.

The aim of this paper is to provide some background information on the changes in the statistical environment ahead[2]. Emphasis will be put on the European situation.

2. The new classification systems

In the last few years the entire international family of classifications was revised; some parts are still in the process of being revised.

2.1 ISIC Rev. 4

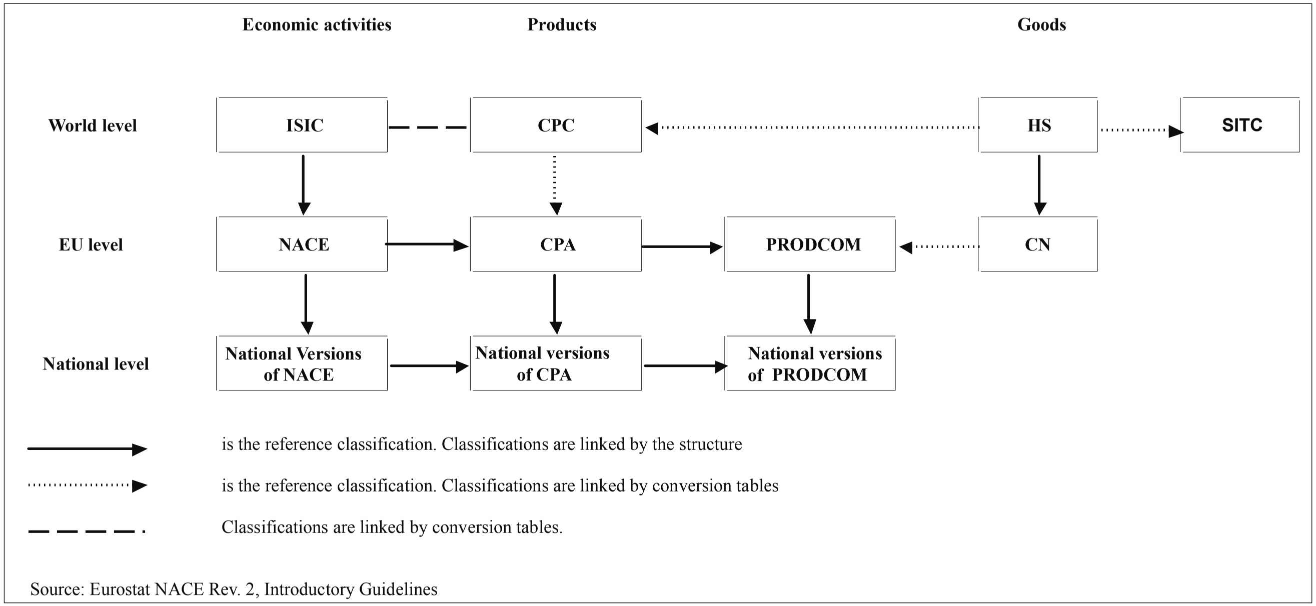
The main objectives of the ISIC revision which led to ISIC Rev. 4 were to reflect new industries and to improve comparability with major

[1] The author is indebted to Ms Ursula Havel (Statistics Austria, National Accounts) for providing additional information and for a number of substantial improvements.

[2] The contribution is based on the state of affairs of September 2008.

Maurizio Grassini and Rossella Bardazzi (edited by), *Energy Policy and International Competitiveness*,
ISBN 978-88-6453-040-6 (print) ISBN 978-88-6453-043-7 (online)

Figure 1. A family of classification systems.



ISIC: United Nations' International Standard Industrial Classification of all Economic Activities.
CPC: United Nations' Central Product Classification.
HS: Harmonized Commodity Description and Coding System, managed by the World Customs Organisation.
NACE: European Classification of Activities. The term is derived from the French title «Nomenclature générale des Activités économiques dans les Communautés Européennes» (Statistical classification of economic activities in the European Communities).
CPA: European Classification of Products by Activity.
PRODCOM: European classification of goods used for statistics on industrial production.
CN: Combined Nomenclature, a European classification of goods used for foreign trade statistics.

regional classifications. Another major criterion was to guarantee a certain degree of coherence with the previous version of ISIC. Formal editing of the complete publication of ISIC Rev. 4 is in its final stage.

Major changes - compared to ISIC Rev. 3.1 – are:

- Increase in top-level categories;
- Increase in overall detail;
- New concepts (information, professional services, support services);
- More emphasis on services as summarized here below.

	ISIC Rev. 4	ISIC Rev. 3.1
Sections	21	17
Divisions	88	60
Groups	238	159
Classes	419	292

New sections:

E Water supply; sewerage, waste management and remediation activities
J Information and communication
L Real estate activities
M Professional, scientific and technical activities
N Administrative and support service activities
Q Human health and social work activities
R Arts, entertainment and recreation

Section J is entirely new, comprising activities which were previously classified under manufacturing, transportation, business services and personal services. Section J covers activities involving the production and distribution of information and cultural products, provision of the means to transmit or distribute these products, as well as data or communications, information technology activities and the processing of data and other information service activities.

L, M and N are more or less the result of a disaggregation of Section K of ISIC Rev. 3.1, Q and R more or less the result of a disaggregation of Section O of ISIC Rev. 3.1.

Within manufacturing, the repair and installation of machinery and equipment, which was formerly classified under manufacturing of the corresponding type of equipment, is now identified separately in Division 33 (Repair and installation of machinery and equipment).

The manufacture of basic pharmaceutical products and pharmaceutical preparations is now a separate Division. Recycling is not longer classified under the manufacturing heading (Section C) but included in Section E.

Section K (Finance and insurance activities) now also covers activities of holding companies and of trusts, funds and similar financial entities.

A complete correspondence table down to the smallest detail will be available on the UNSD website (<http://unstats.un.org/unsd/cr/registry>).

ISIC and NAICS are still substantially different. NAICS, the North American Industry Classification System was developed on the basis of a production-oriented conceptual framework and classifies units, not activities. However, statistical data collected according to NAICS can be aggregated into the two-digit Divisions of ISIC Rev. 4/NACE Rev. 2, ensuring comparability of data.

2.2 NACE Rev. 2

NACE Rev.2 is the EU version of ISIC Rev. 4. The use of NACE is mandatory within the Statistical System of the EU. In addition to the EU Member States, Norway and Switzerland are committed to using a national version derived from NACE. Moreover, about ten other countries outside the EU, or candidate countries like Croatia and Turkey, refer to NACE for their classification of economic activities.

NACE Rev. 2 has already been established by Regulation (EC) No 1893/2006. A second Regulation (EC) No 973/2007 amends 10 EC Regulations on specific statistical domains implementing the statistical classification of economic activities NACE Rev. 2.

Short term business statistics for manufacturing have already started to use NACE Rev. 2, starting with the reference year 2008. Short term business statistics for trade and services will follow starting with the reference year 2009. All short term indicators (with the new base year 2005 = 100) will be based on NACE Rev. 2 also starting from 2009. National accounts data in a breakdown by NACE Rev. 2 categories will be available from 2011 onwards.

Four types of correspondence between NACE Rev. 1.1 and NACE Rev. 2 can be distinguished:

1. 1 to 1 correspondence: 195 classes in NACE Rev. 1.1 correspond exactly to one class in NACE Rev. 2 and vice-versa;
2. n to 1 correspondence: 86 cases, where two or more classes in NACE Rev 1.1 correspond to one class in NACE Rev. 2;
3. 1 to m correspondence: 18 cases, where one NACE Rev. 1.1 class is split into two or more classes in NACE Rev. 2;
4. n to m correspondence: 215 cases, where two or more classes in NACE Rev. 1.1 correspond to two or more classes in NACE Rev. 2.

The implementation of the revised classifications NACE and CPA in the EU with all its far reaching consequences has been tackled t in a special project called «Operation 2007».

The implementation of the revised NACE in EU statistics also implies a disruption of all time series based on NACE Rev. 1 or NACE Rev. 1.1. In order to achieve a certain harmonization of methods in the EU, a handbook on back casting was produced, aiming at providing information to statisticians implementing NACE Rev. 2 in the European Statistical System. For each methodology, it presents the description, some examples and discusses possible advantages and disadvantages. The handbooks are available from <http://forum.europa.eu.int/irc/dsis/nacecpacon/info/data/en/index.htm>.

NACE Rev. 2 – National accounts

Implementation of NACE Rev. 2 for national accounts is foreseen for September 2011. For national accounts purposes, five different levels of aggregation are planned (as of May 2008):

Current transmission obligations have been translated as

A6 → A*10
A17 → A*21
A31 → A*38
A60 → A*64

The A*64 (Level 5) is the most relevant level of aggregation for INFORUM modeling, because it is the future disaggregation of supply and use tables.

A * 64 LEVEL

Code	NACE Rev. 2 div.	Description
1	01	Crop and animal production, hunting and related service activities
2	02	Forestry and logging
3	03	Fishing and aquaculture
4	05-09	Mining and quarrying
5	10-12	Manufacture of food products, beverages and tobacco products
6	13-15	Manufacture of textiles, wearing apparel and leather products

7	16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
8	17	Manufacture of paper and paper products
9	18	Printing and reproduction of recorded media
10	19	Manufacture of coke and refined petroleum products
11	20	Manufacture of chemicals and chemical products
12	21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
13	22	Manufacture of rubber and plastics products
14	23	Manufacture of other non-metallic mineral products
15	24	Manufacture of basic metals
16	25	Manufacture of fabricated metal products, except machinery and equipment
17	26	Manufacture of computer, electronic and optical products
18	27	Manufacture of electrical equipment
19	28	Manufacture of machinery and equipment n.e.c.
20	29	Manufacture of motor vehicles, trailers and semi-trailers
21	30	Manufacture of other transport equipment
22	31-32	Manufacture of furniture; other manufacturing
23	33	Repair and installation of machinery and equipment
24	35	Electricity, gas, steam and air conditioning supply
25	36	Water collection, treatment and supply
26	37-39	Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services
27	41-43	Construction
28	45	Wholesale and retail trade and repair of motor vehicles and motorcycles
29	46	Wholesale trade, except of motor vehicles and motorcycles
30	47	Retail trade, except of motor vehicles and motorcycles
31	49	Land transport and transport via pipelines
32	50	Water transport
33	51	Air transport
34	52	Warehousing and support activities for transportation
35	53	Postal and courier activities
36	55-56	Accommodation; food and beverage service activities
37	58	Publishing activities
38	59-60	Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities

39	61	Telecommunications
40	62-63	Computer programming, consultancy and related activities; information service activities
41	64	Financial service activities, except insurance and pension funding
42	65	Insurance, reinsurance and pension funding, except compulsory social security
43	66	Activities auxiliary to financial services and insurance activities
44	68	Real estate activities
44a		*of which: imputed rents of owner-occupied dwellings*
45	69-70	Legal and accounting activities; activities of head offices; management consultancy activities
46	71	Architecture and engineering activities; technical testing and analysis
47	72	Scientific research and development
48	73	Advertising and market research
49	74-75	Other professional, scientific and technical activities; veterinary activities
50	77	Rental and leasing activities
51	78	Employment activities
52	79	Travel agency, tour operator reservation service and related activities
53	80-82	Security and investigation activities; services to buildings and landscape activities; office administrative, office support and other business support
54	84	Public administration and defence; compulsory social security
55	85	Education
56	86	Human health activities
57	87-88	Social work activities
58	90-92	Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities
59	93	Sports activities and amusement and recreation activities
60	94	Activities of membership organisations
61	95	Repair of computers and personal and household goods
62	96	Other personal service activities
63	97-98	Activities of households as employers of domestic personnel and undifferentiated goods and services production of households for own use
64	99	Activities of extraterritorial organizations and bodies

A two-step implementation is proposed according to length of back data (back to 2000 in 2011, back to 1995 or 1990 in 2012). As regards the length of the time series which have to be made available, the transmission program will make a distinction between «old member countries» and «new member countries», a distinction which will lead to a certain «two-class society». The main time series according to Table 1 of the transmission program will be obligatory from 1990 for Belgium, Denmark, Germany, Ireland, Greece, Spain, France, Italy, Luxembourg, the Netherlands, Austria, Portugal, Finland, Sweden and the United Kingdom. Bulgaria, the Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Romania, Slovenia and Slovakia will be obliged to start their series from 1995.

Tables 15 (supply table) and 16 (use table) must be transmitted for the first time using the P*64 breakdown for the reference period 2008, by 31 December 2011. Tables 17, 18 and 19 (symmetric input-output tables, product by product) must be transmitted for the first time using the P*64 breakdown for the reference period 2010, by 31 December 2013.

For supply-use and input-output tables no backward data is requested.

2.3 CPC Ver. 2

The revised Central Product Classification CPC is still at the draft stage. The draft is available on the UNSD homepage <http://unstats.un.org/unsd/cr>. Some editing needs to be done and explanatory notes will be added. However, no changes to the structure are expected.

The CPC arranges products according to physical characteristics and services. This criterion includes, for example, the type of raw material used, the production process involved, the purpose for which the goods are intended, etc. Although this criterion is often the same as the one used for the classification of economic activities, the CPC is not a product classification dependent on the classification of economic activities. The CPC coding system is independent of ISIC.

2.4 CPA 2008

The CPA is the EU version of the CPC, and the purposes it serves are in line with those of the CPC. The use of CPA 2008 is also mandatory in the EU and based on Regulation (EC) No 451/2008 of the European Parliament and of the Council.

In the EU, product classifications for specific statistical domains are linked to the CPA unless the CPA is itself used as a survey classification.

Although the CPA is the European counterpart of the CPC, it differs from the latter, not only in that it is usually more detailed, but also as regards its structure. The EU adopted the criterion of using economic sources for its development, with NACE as the reference framework. Therefore, up to the fourth level (class) the structure of the CPA corresponds to NACE. The link between the CPA and NACE Rev. 2 is evident in the CPA code: the coding of the first four digits is identical with that used in NACE Rev. 2, with very few exceptions.

3. Revision of the system of national accounts

3.1 SNA 2003 Rev – SNA 2008

In 2003, the UN Statistical Commission called for an update of the System of National Accounts 1993 (SNA 1993) to bring the System into line with the new economic environment, with advances in methodological research and to remove the inconsistencies present in the SNA 1993.

The Inter-secretariat Working Group on National Accounts (ISWGNA) was asked to coordinate and manage the project. The result of these efforts is usually called SNA 1993 Rev, but sometimes also termed SNA 2008. The Inter-secretariat Working Group on National Accounts comprised experts from Eurostat, the International Monetary Fund, the OECD, the United Nations and the World Bank. In addition an Advisory Expert Group (AEG) was established, consisting of 20 experienced national accountants from Statistical Offices around the world.

According to the Report of the Inter-secretariat Working Group on National Accounts to the UN Statistical Commission 2007 (Doc E/CN.3/2007/7) «the majority of the recommendations relate to units and transactions that represent characteristics of an increasingly globalized economy; come from increased interest in the sources of wealth and debt; recognize the increasing role of intangible non financial assets; take into account further innovation in financial markets; reflect the interest in better measures of the impact of pension liabilities in the context of an ageing population; and recognize the need for better measures of government and public-sector debt and deficit».

Early on in the process a general agreement was reached that the revision should deal with issues emerging from new economic developments such as globalisation, but that no fundamental changes should be made to the System. In addition, the need for clarification of a number of regulations was acknowledged. Close co-ordination of the update of the 1993 SNA and the revision of the Balance of Payments Manual, Fifth Edition is another outstanding feature.

In March 2007, the UN Statistical Commission adopted the report presented by the ISWGNA on the SNA update, covering recommendations on 44 issues identified. On five issues, listed below, world-wide consultation revealed a lack of unanimity with the AEG recommendations: (i) government employer pension schemes and social security schemes; (ii) research and development; (iii) goods for processing; (iv) military expenditures; and (v) inclusion of capital services in non-market production (not adopted). With their adoption, these recommendations, together with the additional considerations, are officially recognised as the basis for the revised (new) SNA. Documentation of the state of revision is available from <http://unstats.un.org/unsd/sna1993/snarev1.asp>.

The revised SNA will be supplied in two-parts. Volume 1 was already submitted to the UN Statistical Commission in March 2008. Volume 1 comprises the full set of chapters that represent the SNA framework in terms of accounting conventions, the accounts, and the integration of the accounts. Volume 1 incorporates the recommendations adopted on the 44 issues for which full consensus was reached. Volume 2 comprises mainly the interpretation of the accounts and various extensions such as satellite accounts. According to schedule it should be ready by December 2008 and should be submitted to the UN Statistical Commission in March 2009.

List of issues considered in the update of the 1993 SNA

1 Repurchase agreements
2 Employers' pension schemes
3 Employee stock options
4a Non-performing loans
4b Valuation of loans and deposits; Write-off and interest accrual on impaired loans
38c Application of the accrual principle to debt in arrears
5 Non-life insurance
6a Financial services
6b Allocation of the output of central banks
7 Taxes on holding gains
8 Interest under high inflation
9 Research and development (R&D)
10 Patented entities
11 Originals and copies
12 Databases
13 Other intangible fixed assets
14 Costs of ownership transfer
15 Cost of capital services
16 Government and non-market producers: cost of capital of own assets
17 Mineral exploration

18 Right to use/exploit non-produced resources between residents and non-residents
19 Military expenditures
20 Land improvements
21 Contracts, leases and licences
22 Goodwill and other non-produced assets
23 Obsolescence and consumption of fixed capital
24 Public-private partnerships (PPPs) (including buy-own-operate-transfer (BOOT) schemes)
25a Ancillary units
25b Holding companies, special purpose entities, trusts
25c Treatment of multi-territory enterprises
25d Non-resident unincorporated units
25e Non-resident SPEs controlled by government
26 Cultivated assets.
27 Classification and terminology of assets
28 Amortization of non-produced assets
29 Assets boundary for non-produced intangible assets
30 Definition of economic assets
31 Water as an asset
32 Informal sector
33 Illegal activities
34 Government transactions with public corporations: earnings from equity investment and capital injections
35 Tax revenues, uncollectable taxes and tax credits
36 Public/private/government sectors delineation
37 Granting and activation of loan guarantees
38a Change of economic ownership (as term)
38b Assets, liabilities and personal effects of individuals changing residence («migrants' transfers»)
38c Application of accrual principles to debt in arrears
39a Meaning of national economy
39b Predominant centre of economic interest (as term)
39c Residence of entities with little or no physical presence
39d Non-permanent workers
40 Goods for Processing
41 Merchanting
42 Retained earnings of mutual funds, insurance companies and pension funds
43a Treatment of index-linked debt instruments
43b Debt indexed to a foreign currency
43c Interest at concessional rates
43d Fees payable on securities lending and gold loans
44 Financial assets classifications

As might be seen from this list many issues deal with non-financial assets (more than 20), financial services, financial instruments and government and the public sector in general. A group of issues is also devoted to the relations of the national economy with the rest of the world and to the central question of the underlying statistical units.

According to the report by the ISWGNA to the Statistical Commission (Paper E/CN.3/2007/7) the following solutions will be incorporated as far as the most controversial issues are concerned:

Issue 9 Research and development

Research and development should be treated as gross fixed capital formation. It should be defined as in the Frascati manual, namely as «research and experimental development comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including the knowledge of man, culture and society and use of this stock of knowledge to devise new applications.» This definition should not be interpreted as including human capital as capital formation within the SNA. Since much R&D is carried out on own account, it should be valued at cost.

Issue 15 Cost of capital services

Given the importance of identifying capital services for productivity measurement and other analysis, a new chapter will be added explaining their role and appearance in the System and stressing the desirability of calculating capital services, capital stock and consumption of fixed capital in an integrated and consistent manner. No changes will be made to standard entries in the accounts showing capital services but an explanation will be provided of how optional, supplementary items or tables could be derived and presented. The identification of the cost of capital for market producers is voluntary within the recommended supplementary accounts.

Issue 16 Government and other non-market producers: cost of capital of own assets

No agreement was reached concerning the proposal that a return to fixed capital owned and used by non-market producers should be included in the estimation of the output of those producers in addition to estimates of consumption of fixed capital.

Issue 19 Military expenditures

In contrast with previous conventions all military expenditure that meets general SNA criteria for capital formation — that is, used in production over a period in excess of one year — will be treated as capital formation in the revised SNA. Weapon systems and military inventories would be distinguished within fixed capital formation and inventories, respectively.

Issue 40 Goods for processing

Imports and exports should be recorded on a strict change of ownership basis. Goods being processed in one country on behalf of a unit residing in an other country would no longer be part of imports and exports in the balance of payments and SNA. This decision has implications for the input-output tables, which on the basis proposed will reflect what each unit contributes to the production process rather than the physical technology, as was the case before.

How to measure transactions in volume terms does not appear among the issues considered in the revision process. Nevertheless, some excerpts of Chapter 15 of the Draft SNA 2008 (Volume 1) show a certain re-orientation in this respect compared to the SNA 1993:

> 15.166 The recommendations reached above on expressing national accounts in volume terms may be summarized as follows:
>
> a. Volume estimates of transactions in goods and services are best compiled in a supply and use framework, preferably in conjunction with, and at the same time as, the current value estimates. This implies working at as detailed a level of products as resources permit.
>
> f. The preferred measure of year-to-year movements of GDP volume is a Fisher volume index; changes over longer periods being obtained by chaining: that is, by cumulating the year-to-year movements.
>
> g. The preferred measure of year-to-year inflation for GDP and other aggregates is, therefore, a Fisher price index; price changes over long periods being obtained by chaining the year-to-year price movements, or implicitly by dividing the Fisher chain volume index into an index of the current value series.
>
> h. Chain indices that use Laspeyres volume indices to measure year-to-year movements in the volume of GDP and the associated implicit Paasche price indices to measure year-to-year inflation provide acceptable alternatives to Fisher indices.
>
> i. Chain indices for aggregates cannot be additively consistent with their components whichever formula is used, but this need not prevent time series of values being compiled by extrapolating base year values by the appropriate chain indices.

A provision similar to the one in the SNA 1993 that «disaggregated constant price data should be compiled and published *in addition* [emphasis added] to the chain indices for the main aggregates. The need to publish two sets of data that may appear to conflict with each other should be readily appreciated by analysts engaged in macroeconomic modelling and forecasting» (SNA 1993, 16.75) is missing.

3.2 Revision of the European system of national accounts ESA

In the EU national accounting is governed by legally binding regulations because results of national accounts are to a large extent directly used for operational/administrative purposes. Examples are the own resources of the EU, structural funds, EDP and convergence programs. At present Council Regulation No 2223/1996, later amended by several regulations, is in force. The compulsory transmission program in force is laid down in Regulation No 1392/2007.

The European system of national accounts ESA is broadly consistent with the SNA as regards definitions, accounting rules and classifications. Where SNA is flexible and includes several alternatives, ESA generally chooses a particular option to guarantee full comparability at EU level. ESA usually describes a concept by providing a definition and a listing of what is included and what is excluded.

The revision of the SNA will be followed by a revision of the ESA. Changes will cover both methodological references and data transmission requirements.

The project for achieving a new ESA consistent with SNA 2008 will start from the consolidated text, which is the text of Regulation No. 2223/1996 and the Regulations which came into force afterwards. The most important ones deal with:

- allocation of FISIM
- definition of general government expenditure and revenue
- taxes and social contributions unlikely to be collected
- reclassification of settlements under swaps and forward rate arrangements
- revised classification of expenditure according to purpose

The plan is to complete the process of drafting and discussing the new ESA by February 2009. Discussion of the amended transmission programme should also be finished by February 2009.

Adoption of the regulation by the European Parliament and the Council is scheduled for the first quarter of 2011. The new ESA methodology and the new transmission programme should become legally binding in 2014.

4. *Consequences for INFORUM Modelling*

The changes in activity and product classification systems in the near future will probably have more severe consequences on INFORUM modelling activities than the revision of national accounts.

Even a brief look at the new classification systems reveals that the needs of model builders and the builders of input-output models in particular were not taken into account in the revision process.

Industries on the two digit level are still extremely heterogeneous as far as intermediate inputs and inputs of primary factors of production are concerned. No attempts were made to reduce vertical integration with all its undesirable consequences on economic analysis in general and input-output analysis in particular. Examples of such vertically integrated activities are industry 35 (Electricity, gas, steam and air conditioning supply) and industry 17 (Manufacture of paper and paper products). A certain progress can be seen in the fact that at least the manufacture of basic pharmaceutical products and pharmaceutical preparations is now classified in a separate Division. But again this industry is characterized by vertical integration.

The aggregation of NACE Divisions 13, 14 and 15 (textiles, wearing apparel and leather products) into industry 6 (and a corresponding product group) in the EU A*64 and P*64 standard disaggregation must be seen as a major drawback. The A*64/P*64 breakdown will be the standard for compiling supply and use tables. The additional details (compared to the present classification) as far as services are concerned, offer few additional analytical opportunities in an input-output context.

One of the outstanding features of INFORUM models (which have all the properties of macromodels) is that modelling is done on the industry and product level. Estimation of the parameters in all the behavioural equations at an industry/product level, which plays an important role in all INFORUM models, is primarily based on time series information. Long and homogeneous series (as far as the data generating process is concerned) are therefore very important for a sound empirical basis.

The change in the classifications will necessarily lead to disruptions in many time series. In cases in which there is no 1 to 1 correspondence or a n to 1 correspondence between NACE Rev. 1.1 and NACE Rev. 2 the range of meaningful parameter estimation will depend on two factors:

- Whether the Statistical Offices will be ready to produce long homogeneous series, even beyond what is mandatory according to EU regulations.
- On the methods used for the back casting process in the cases of 1 to m and n to m correspondence. In this context it will be of crucial importance that this back casting is done within a coherent methodological framework.

If the back casting is done for each of the series independently of each other, parameter estimation will be seriously biased, reflecting differences in the back casting procedures and not economic behaviour.

In the context of INFORUM models it is worth mentioning that the modifications in the classification systems are rather limited as far as the manufacturing industries/products are concerned. Major discontinuity will only be caused by the isolation of repair and installation of machinery and equipment, which was formerly classified under manufacturing of the corresponding type of equipment.

The change of the classification systems will have a major impact on the quality and the nature of national accounts results in the transition period 2008 to 2011. The results will be presented in disaggregation by NACE Rev. 1.1. The underlying basic statistics, however, have already been produced using the NACE Rev. 2 breakdown and the coverage of statistics such as short term business statistics has also already been determined by NACE Rev .2 criteria. National accountants will have to do a lot of extra modelling work and be quite creative to re-arrange the input data of the new classifications into an old framework. Consequently, even the final results for 2008 and 2009 will not be fully compatible with the results of the reference years before 2008. This specific data situation is an additional source of discontinuity in the time series.

Compared to the implications of changes in the classification systems, relatively minor changes in the overall statistical environment will occur as a result of the revision of the SNA.

This relative overall stability in the SNA also implies that the needs of structural, long-term analysis are no better met by the new System than the old. This is also illustrated by the preference which is given to chaining, rather than using a constant base year. It is quite obvious that in the forthcoming EU versions of the SNA 2008 emphasis will again be laid on the administrative use of national accounts.

The fact that the entire statistical system in the EU is governed by regulations has one advantage for INFORUM modelling. Planning is made easier. Model builders know well in advance what kind of statistical information will be available and when.

Over the next years the statistical environment of INFORUM models will undergo a number of considerable changes: another real challenge for those engaged in building dynamic interindustry models.

References

Commission Regulation (EC) No 973/2007 of 20 August 2007 amending certain EC Regulations on specific statistical domains implementing the statistical classification of economic activities NACE Revision 2.

Commission Regulation (EC) No .../2008 (Draft) amending Council Regulation (EC) No 2223/96 with respect to implementing the statistical classification of economic activities NACE Revision 2 and the statistical classification of products by activity CPA 2008 in national accounts.

Council Regulation (EC) No 2223/96 of 25 June 1996 on the European system of national and regional accounts in the Community.

Eurostat, Imf, Oecd, United Nations, World Bank (1993). System of National Accounts 1993. Brussels, Luxembourg, New York, Paris, Washington D.C.

Eurostat «Operation 2007 website», <http://forum.europa.eu.int/irc/dsis/nacecpacon/info/data/en/index.htm>.

Intersecretariat Working Group on National Accounts; Doc E/CN.3/2007/7, <http://unstats.un.org/unsd/sna1993/snarev1.asp>.

Regulation (EC) No 1893/2006 of the European Parliament and of the Council of 20 December 2006 establishing the statistical classification of economic activities NACE Revision 2 and amending Council Regulation (EEC) No 3037/90 as well as certain EC Regulations on specific statistical domains (Text with EEA relevance).

Regulation (EC) No 1392/2007 of the European Parliament and of the Council of 13 November 2007 amending Council Regulation (EC) No 2223/96 with respect to the transmission of national accounts data (Text with EEA relevance).

Regulation (EC) No 451/2008 of the European Parliament and of the Council of 23 April 2008 establishing a new statistical classification of products by activity (CPA) and repealing Council Regulation (EEC) No 3696/93.

United Nations (2007). Statistical Commission. Thirty-eighth session, 27 February-2 March.

United Nations, Statistical Commission (2007). Thirty-eighth session, 7 February-2 March.

The Full Set of Consolidated Recommendations . The Recommendations Made by the Advisory Expert Group for the Update of the System of National Accounts, 1993 Prepared by the Intersecretariat Working Group on National Accounts, Background document, <http://unstats.un.org/unsd/sna1993/snarev1.asp>.

United Nations (2008). Statistical Commission. Thirty-ninth session, 26-29 February.

Updated System of National Accounts 1993 (1993 SNA): Volume 1: Chapters 1-17, <http://unstats.un.org/unsd/sna1993/snarev1.asp>.

RECONSTRUCTION OF RUSSIAN I-O TABLES IN THE NEW CLASSIFICATION SYSTEM AND ANALYSIS OF STRUCTURAL CHANGES

Marat Uzyakov
Institute for Economic Forecasting, Russian Academy of Sciences

Over the last 20 years Russian economists have faced serious problems in economic analysis at least twice. The first time was after the dissolution of the USSR and the second time – four years ago – was after implementation of the new statistical classification system called the All-Russian Classification of Type of Economic Activity (instead of classification of Industries of the Economy).

Time series were interrupted and it became rather difficult to analyze the dynamics of production, to forecast and to elaborate and use models. The Russian Statistical Office – Rosstat – now produces statistics in the new classification only, and we have no bridge matrices for recalculating earlier tables and time series. The last I-O table produced by Rosstat in the previous classification was for 2003. Rosstat now plans to produce full-scale I-O tables in the new classification, beginning with a table for 2012, to be published some time later.

In this situation, the only answer for performing structural analysis and forecasting was to produce the I-O tables ourselves. Our key idea was: «It is better to have less than perfect I-O tables, than to have no I-O tables at all». I-O tables are very useful not only for modeling but for analytical purposes as well because of the consistency of all the variables in I-O tables.

It was not an easy task for us to produce the I-O tables ourselves because there was not enough statistical information, there were no bridge matrices, etc. Nevertheless, we have finally produced time series of I-O tables for Russia in current and constant prices from 1980 to 2006. These I-O tables are the basis of our analysis of structural changes in the Russian economy.

We put all of our I-O tables into the data bank for the G7 program. With it, we can now use more than 10,000 economic variables from 27 years for analysis, modeling and forecasting.

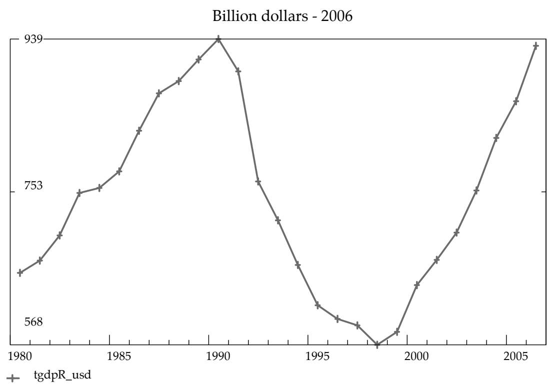
Our time series also includes part of the Soviet period of Russian economic history, but I believe that the most interesting period is the last 17 years, 1990 – 2006, the transition and market period of the Russian economy. I shall therefore focus on this period.

Maurizio Grassini and Rossella Bardazzi (edited by), *Energy Policy and International Competitiveness*,
ISBN 978-88-6453-040-6 (print) ISBN 978-88-6453-043-7 (online)

But this period was not homogeneous. The first part of the period – from 1990 to 1998 was a time of crisis and economic decline. Only after default on state debt and the sharp fall of the Russian ruble in 1998 did economic recovery and growth begin. Since 1999, economic growth in Russia has been continuous for 10 years. So the main turning points in my analysis will be 1990 and 1998, while 2006 is frequently mentioned because it is the last year of data.

These three periods of Russian economic development are clearly seen in the GDP trends.

Figure 1. GDP – Constant prices.



To put the graph into familiar units, it has been expressed in billions of 2006-constant USA dollars. At present, in 2008, Russian GDP is estimated as approximately 1800 billion dollars. The difference between the 939 billion dollars in 2006 shown in the graph and 1800 billion dollars in 2008 is explained by the very fast nominal dynamics of Russia's GDP (more then 25% a year) and nominal weakness of the USA dollar.

A more detailed impression of the evolution of Russian's economy is given by the table below.

Table 1. Components of Russian GDP.

	RATES OF GROWTH %		
	80-90	90-98	98-06
Personal consumption	3.5	-3.8	7.9
Government purchases	4.0	-8.3	1.9
Investment	3.7	-15.7	9.9
Exports	3.5	-3.7	6.9
Imports	4.4	-8.4	9.6
GDP	3.6	-6.3	6.2

In this table we use growth rates with continuous or logarithmic compounding, so that we can easily compare rates of growth with rates of decline. We can see from this table that the growth rates of Investment and of Government purchases in the period of economic recovery (1999-2000) were slower than the declining rates in the initial period of market reforms. Vice versa, the positive dynamics of Exports, Imports, and Personal consumption were faster than the rates of decline of these components in the previous period.

These differences in dynamics of components of final demand define the direction and the depth of structural changes in the Russian economy on a macro level.

But the main question is «What were the reasons for such different dynamics in the components of final demand?» To answer this question is to explain the reasons for and mechanism of decline at the beginning of 1990s and subsequent economic growth. I shall not go into this in detail now but it is well known that the main reasons for the decrease of production at the beginning of 1990's were as follows:

- disruption of traditional economic ties between former Soviet republics;
- drastic changes in price proportions caused by price liberalization and the liberalization of foreign trade which made the inefficiency and unprofitability of many enterprises clear;
- the sharp fall in final demand as a result of hyperinflation.

In conditions of large-scale reduction of production there was practically no need for investment, so the drop in investment was spectacular and reached 80% compared to the 45% fall in production. As a result, the share of investment in GDP declined sharply in the 1990's.

Figure 2. Investment.

Declining investment resulted in a corresponding reduction of the production of Machinery, Construction, and Construction materials.

Figure 3. Machinery Industries.

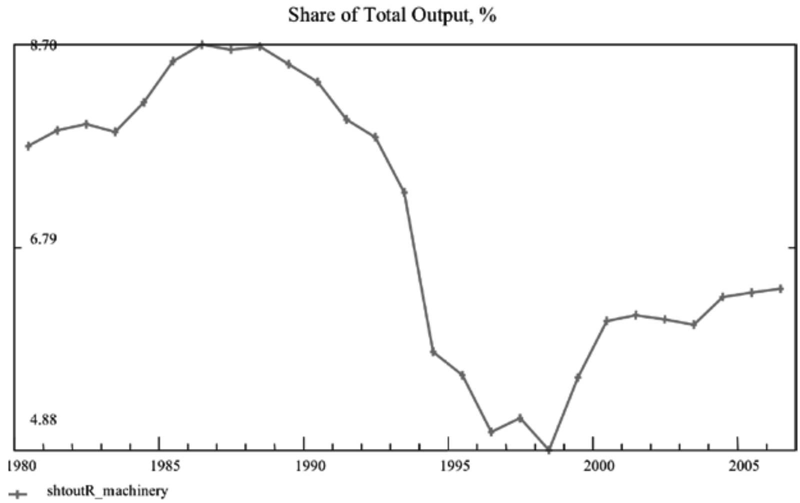
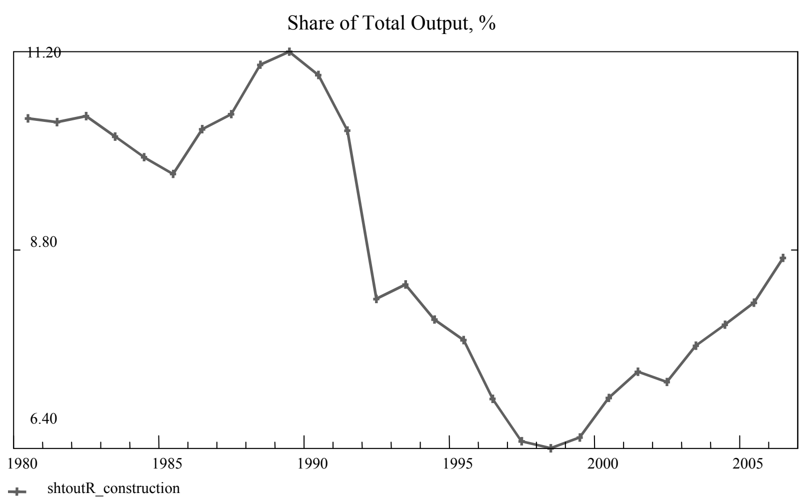
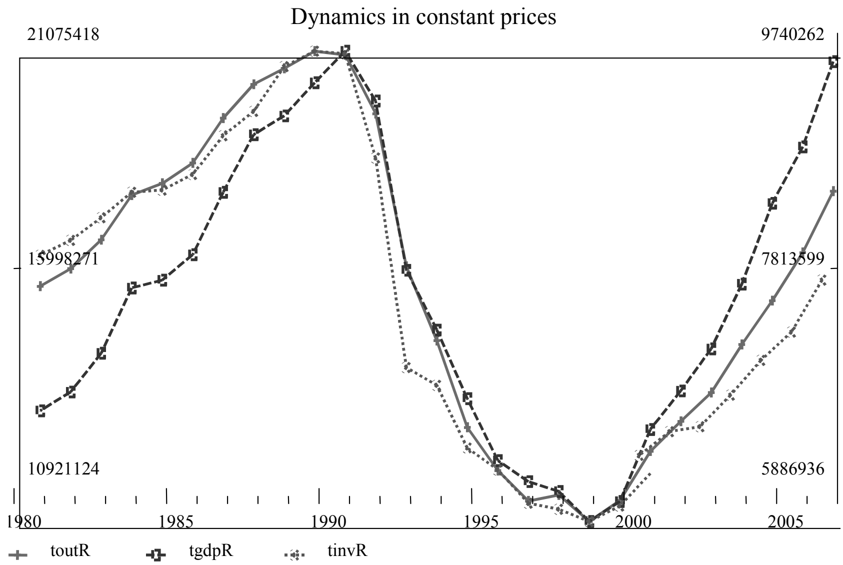


Figure 4. Construction.



The next graph illustrates the changes in efficiency of the Russian economy and gives some explanation of the relatively slow recovery of the share of Investment in GDP.

Figure 5. Total output, GDP, Investment.



As we can see in this graph, since 1998 GDP has almost recovered its position. As for total output, its dynamics were somewhat slower because of the reduction of total material-intensity. The much more limited recovery of Investment was partly connected with an increase in efficiency. But the main explanation for this phenomenon was the large amount of unused production capacities which had accumulated during the previous recession period, so that over the last eight years the Russian economy did not need large investment because it only restored the previous volume of production and some of the former capacity, as with electricity generation and rail transportation, still existed and was usable.

We can conclude now that the dynamics of the Investment share of GDP, as indeed the dynamics of Machinery and of Construction in total output were quite natural and reflect the adaptation of the investment process to the crisis, decline and subsequent recovery of production.

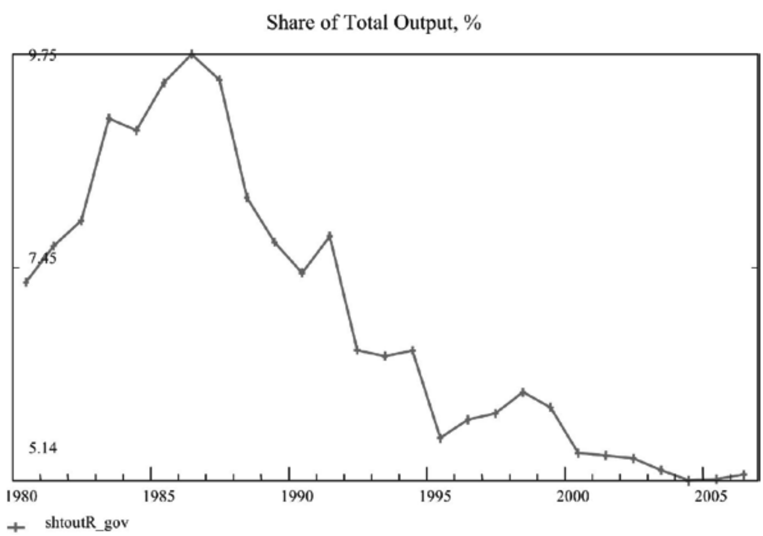
But now, in 2008, when practically all the reserves of capacities have already been used up, the share of Investment in GDP needs to be increased significantly to maintain high growth rates in Russia.

Another component of final demand which, along with Investment, showed a declining share in GDP was Government purchases.

Figure 6. Government Purchases.

The reduction of the share of Government purchases in GDP reflects the decreasing role of the state in the process of market transformation and the significant reduction of military expenditure, especially in the first years of market reforms. The natural result of such changes was the reduction of the share «Government, defense and social insurance' of total output.

Figure 7. Government



The shares of Personal consumption, Exports and Imports of GDP increased, especially in the latter period.

As for Exports, the main explanation of its dynamics was the drastic reduction of internal demand for raw materials in the first period of reform and the favorable price conditions on the world mineral resources markets in the latter period. As a result, the shares of fuel and of metals in total exports increased from about 25% in 1990 to more than 70% in recent years.

For some years, exports became the main driver of the fuel and metallurgical industries. Exports defined almost all production dynamics. Export shares of industrial production increased significantly.

However, over the last few years, the rates of growth in fuel and metallurgy sharply decreased because of primary resource and capacity restrictions. Conditions of high economic growth in Russia and growing internal demand led to a certain decrease in the export share of output.

Figure 8. Export and Import.

Personal consumption showed the least elasticity in relation to the decline in production, so its share increased over all periods except 1999-2000, when there was a rapid growth of investment.

The key industry supporting consumption in the period of the crisis was Agriculture. Its share increased significantly in the period of general decline of production and then began gradually to decrease in the period of economic recovery.

Figure 9. Fuel Industries.

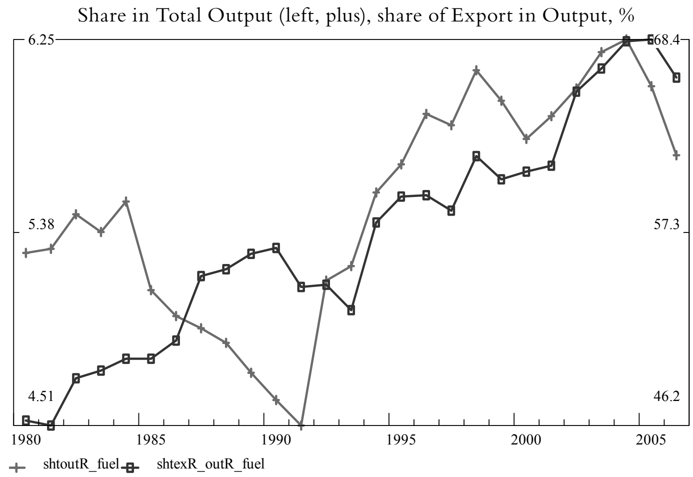
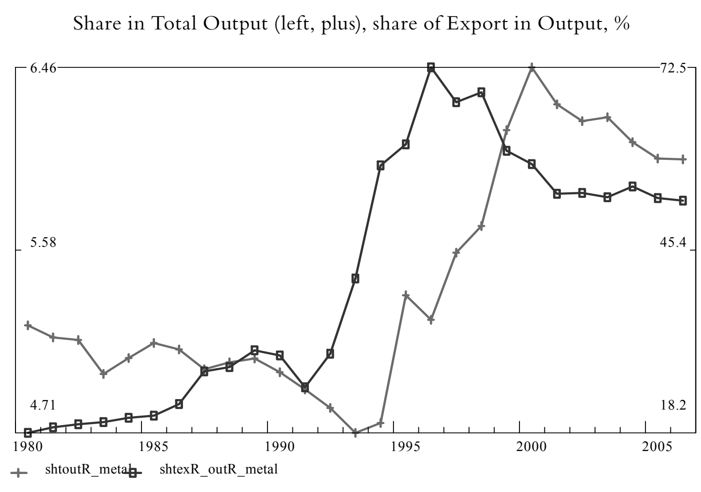


Figure 10. Metallurgy Industries



As for imports, they fell sharply at the beginning of the 1990's because of the drastic fall in the ruble and then began to regain their position with strengthening of the ruble. Most imports are consumer goods and services, so the dynamics of the import share repeats the dynamics of the Personal consumption share. As a result, the dynamics of production of many consumer goods influenced both changes in personal consumption and imports. Some industries, such as Textiles and Leather products, could not compete with imports and sharply reduced production. Others, such as Food and Automobiles, not only maintained but actually expanded their production.

As for services, their share of total production grew very rapidly in the first period of transition in spite of decreasing government services. This trend was first reversed with the beginning of the recovery in 1999-2000 and then the trend of an increasing share of services reappeared.

Figure 11. Import and Personal Consumption.

Figure 12. Agriculture.

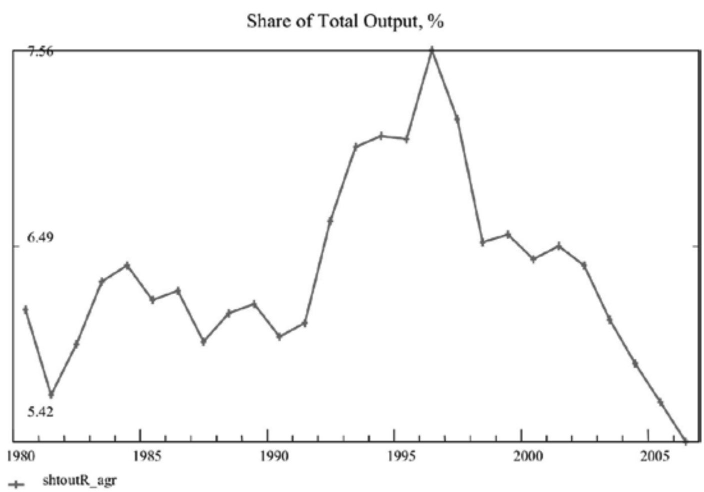


Figure 13. Food Industries.

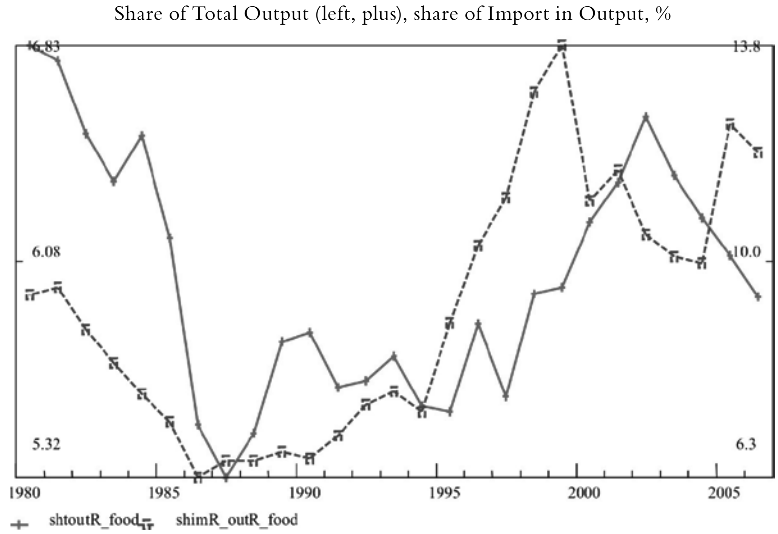
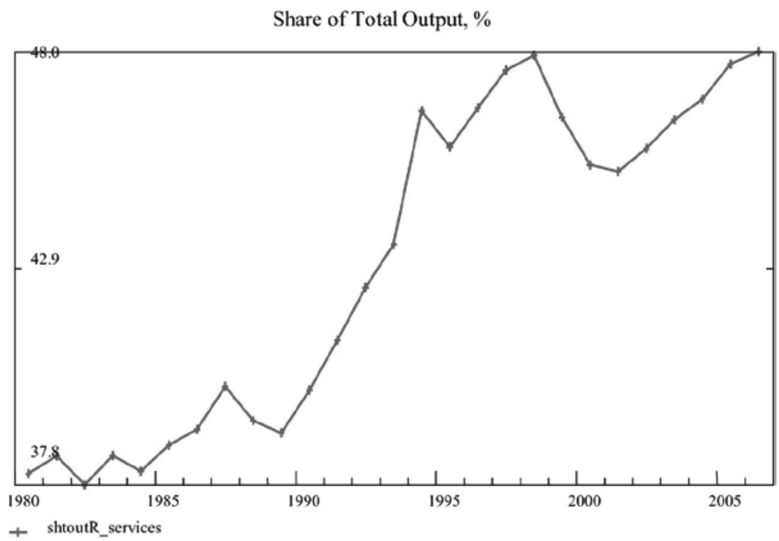


Figure 14. Services.



The main changes in output structure are shown in the next table. A more detailed picture of structural changes in the Russian economy, including the structure of final demand components, is shown in the tables of the Appendix. These tables contain our new I-O tables for a full set of industries.

	Share of total output, %			
	1980	1990	1998	2006
Agriculture	6.1	6.0	6.5	5.4
Industry	45.4	43.1	39.2	37.8
including:				
Fuel	5.3	4.6	6.1	5.7
Metallurgy	5.2	5.0	5.7	6.0
Machinery	7.7	8.3	4.9	6.4
Food	6.8	5.8	6.0	
Construction	10.4	10.9	6.4	8.7
Services	38.0	40.0	47.9	48.0
including:				
Trade	10.3	12.0	17.2	17.9
Communication	0.7	0.9	1.2	2.6
Transport	6.8	6.8	6.6	5.6
Government	7.3	7.4	6.1	5.2

Appendix

	SHARE OFTOTAL OUTPUT, % (constant prices)			
	1980	1990	1998	2006
Agriculture	6.1	6.0	6.5	5.4
Petroleum extraction	4.4	3.7	4.8	4.6
Natural gas extraction	0.3	0.5	0.8	0.6
Coal mining	0.5	0.4	0.5	0.4
Other Fuels, incl. nuclear	0.1	0.1	0.1	0.0
Ores and other mining	1.7	1.7	1.4	1.3
Food, beverages, tobacco	6.8	5.8	6.0	6.0
Textiles, apparel, leather	2.5	2.3	0.7	0.6
Wood and wood products	1.0	1.0	0.7	0.7
Paper and printing	1.6	1.5	1.0	0.8
Petroleum refining	4.7	3.7	4.2	3.3
Chemicals	1.4	1.7	1.4	1.6
Pharmaceuticals	0.1	0.1	0.1	0.1
Plastic products	1.4	1.4	0.7	0.6
Stone, Clay, and Glass products	1.8	1.6	1.0	1.1

Ferrous metals	2.1	2.0	2.3	2.3
Non-ferrous metals	- 2.7	2.5	2.9	3.1
Fabricated metal products	0.5	0.5	0.5	0.7
Machinery	3.4	3.7	2.1	2.7
Computers, office machinery	0.2	0.2	0.0	0.0
Electrical apparatus	0.5	0.5	0.4	0.7
Radio, television, communication equipment	0.1	0.1	0.1	0.2
Medical, optical, and precision instrument	0.1	0.1	0.0	0.1
Automobiles, highway transport equipment	1.5	1.7	1.2	1.7
Sea transport equipment and its repair	0.2	0.2	0.1	0.2
Airplanes, rockets, and repair	1.7	1.7	0.7	0.5
Railroad equipment and its repair	0.1	0.2	0.2	0.3
Recycling	0.9	0.9	0.6	0.6
Electric, gas, and water utilities	3.2	3.5	4.8	3.0
Construction	10.4	10.9	6.4	8.7
Wholesale and retail trade	10.3	12.0	17.2	17.9
Hotels and restaurants	0.3	0.4	0.7	1.0
Transport and storage	6.8	6.8	6.6	5.6
Communication	0.7	0.9	1.2	2.6
Finance and insurance	3.0	2.0	1.7	2.7
Real estate	3.4	3.9	5.8	6.7
Equipment rental	0.2	0.1	0.1	0.1
Computing service	0.1	0.1	0.1	0.1
Research and development	3.0	3.0	2.0	1.1
Other business services	0.1	0.1	0.1	0.3
Government, defense, social insurance	7.3	7.4	6.1	5.2
Education	1.1	1.1	1.9	1.3
Health services	1.5	1.6	2.7	1.8
Other social and personal services	0.4	0.6	1.8	1.6

SHARE OF TOTAL OUTPUT, % (current prices)				
	1980	1990	1998	2006
Agriculture	8.4	11.1	6.8	4.4
Petroleum extraction	0.8	0.8	2.9	5.3
Natural gas extraction	0.4	0.9	0.5	1.0
Coal mining	0.7	0.6	0.7	0.6
Other Fuels, incl. nuclear	0.0	0.2	0.1	0.1
Ores and other mining	1.0	1.1	1.2	1.2
Food, beverages, tobacco	9.5	8.7	5.9	6.3
Textiles, apparel, leather	7.2	5.5	0.8	0.8
Wood and wood products	0.9	1.0	0.6	0.9
Paper and printing	1.4	1.4	0.8	1.0
Petroleum refining	1.9	1.6	2.3	3.3
Chemicals	1.9	1.9	1.5	1.7
Pharmaceuticals	0.2	0.2	0.1	0.2
Plastic products	1.2	1.1	0.7	0.6
Stone, Clay, and Glass products	1.9	1.7	1.3	1.2
Ferrous metals	1.9	1.8	1.9	2.8
Non-ferrous metals	-1.3	1.7	2.2	2.9
Fabricated metal products	1.0	0.9	0.5	0.6
Machinery	6.0	5.5	2.5	2.6
Computers, office machinery	0.2	0.2	0.1	0.0
Electrical apparatus	0.8	0.7	0.5	0.6
Radio, television, communication equipment	0.2	0.2	0.2	0.3
Medical, optical, and precision instrument	0.1	0.1	0.1	0.1
Automobiles, highway transport equipment	3.3	3.0	1.3	1.6
Sea transport equipment and its repair	0.2	0.2	0.1	0.2
Airplanes, rockets, and repair	2.2	1.8	0.7	0.5
Railroad equipment and its repair	0.3	0.3	0.2	0.3
Recycling	1.1	1.0	0.7	0.6

Electric, gas, and water utilities	1.4	1.6	7.4	4.7
Construction	6.5	7.2	7.4	6.4
Wholesale and retail trade	11.6	11.3	13.3	15.0
Hotels and restaurants	1.0	0.9	0.6	0.9
Transport and storage	7.2	7.0	7.7	7.8
Communication	1.0	1.0	2.0	1.0
Finance and insurance	1.7	1.5	2.2	2.8
Real estate	1.7	1.7	5.3	5.9
Equipment rental	0.1	0.1	0.1	0.2
Computing service	0.0	0.0	0.1	0.2
Research and development	2.0	2.5	1.7	1.4
Other business services	0.0	0.0	0.1	0.2
Government, defense, social insurance	5.4	5.1	7.1	5.5
Education	1.3	1.4	2.4	2.0
Health services	1.9	2.1	3.2	2.8
Other social and personal services	1.1	1.2	1.9	1.8

SHARE OF TOTAL PERSONAL CONSUMPTION, % (constant prices)				
	1980	1990	1998	2006
Agriculture	9.3	8.3	12.0	7.7
Petroleum extraction	0.0	0.0	0.0	0.0
Natural gas extraction	0.1	0.0	0.1	0.1
Coal mining	0.0	0.0	0.0	0.0
Other Fuels, incl. nuclear	0.0	0.0	0.0	0.0
Ores and other mining	0.0	0.0	0.0	0.0
Food, beverages, tobacco	29.5	22.1	18.6	17.7
Textiles, apparel, leather	12.4	12.8	8.9	9.9
Wood and wood products	0.0	0.1	0.0	0.1
Paper and printing	0.6	0.9	0.5	0.6
Petroleum refining	0.0	0.1	0.2	0.1
Chemicals	0.2	0.4	0.4	0.5
Pharmaceuticals	0.2	0.4	0.4	0.6
Plastic products	0.2	0.4	0.3	0.3
Stone, Clay, and Glass products	0.3	0.3	0.3	0.3

Ferrous metals	0.0	0.0	0.0	0.0
Non-ferrous metals	- 0.0	0.0	0.0	0.0
Fabricated metal products	0.4	0.5	0.4	0.6
Machinery	1.3	1.6	1.3	1.7
Computers, office machinery	0.1	0.1	0.1	0.0
Electrical apparatus	0.1	0.1	0.1	0.2
Radio, television, communication equipment	0.1	0.2	0.2	0.4
Medical, optical, and precision instrument	0.0	0.0	0.0	0.0
Automobiles, highway transport equipment	2.5	3.2	2.5	3.3
Sea transport equipment and its repair	0.1	0.1	0.1	0.2
Airplanes, rockets, and repair	0.7	0.8	0.5	0.4
Railroad equipment and its repair	0.0	0.0	0.0	0.0
Recycling	1.4	1.6	1.0	0.9
Electric, gas, and water utilities	2.7	2.8	2.8	1.6
Construction	1.3	1.3	0.6	0.9
Wholesale and retail trade	16.2	18.5	19.9	20.6
Hotels and restaurants	1.5	1.8	2.3	2.7
Transport and storage	6.7	7.2	6.1	5.9
Communication	0.2	0.8	1.4	3.1
Finance and insurance	0.4	0.4	0.7	0.9
Real estate	6.9	8.0	9.4	10.7
Equipment rental	0.0	0.0	0.0	0.1
Computing service	0.2	0.2	0.2	0.1
Research and development	0.0	0.0	0.0	0.0
Other business services	0.0	0.0	0.0	0.1
Government, defense, social insurance	1.1	1.1	1.5	1.7
Education	1.0	1.0	1.3	1.1
Health services	1.9	1.8	2.4	2.0
Other social and personal services	0.6	1.1	3.7	2.8

SHARE OF TOTAL GOVERNMENT PURCHASES, % (constant prices)	1980	1990	1998	2006
Agriculture	0.6	0.7	0.7	0.3
Petroleum extraction	0.0	0.0	0.0	0.0
Natural gas extraction	0.0	0.0	0.0	0.0
Coal mining	0.0	0.0	0.0	0.0
Other Fuels, incl. nuclear	0.0	0.0	0.0	0.0
Ores and other mining	0.0	0.0	0.0	0.0
Food, beverages, tobacco	0.0	0.0	0.0	0.0
Textiles, apparel, leather	0.0	0.0	0.0	0.1
Wood and wood products	0.0	0.0	0.0	0.0
Paper and printing	0.0	0.0	0.0	0.0
Petroleum refining	0.0	0.0	0.0	0.0
Chemicals	0.0	0.0	0.0	0.0
Pharmaceuticals	0.0	0.0	0.0	0.2
Plastic products	0.0	0.0	0.0	0.0
Stone, Clay, and Glass products	0.0	0.0	0.0	0.0
Ferrous metals	0.0	0.0	0.0	0.0
Non-ferrous metals	- 0.0	0.0	0.0	0.0
Fabricated metal products	0.0	0.0	0.0	0.0
Machinery	0.0	0.0	0.0	0.0
Computers, office machinery	0.0	0.0	0.0	0.0
Electrical apparatus	0.0	0.0	0.0	0.0
Radio, television, communication equipment	0.0	0.0	0.0	0.0
Medical, optical, and precision instrument	0.0	0.0	0.0	0.0
Automobiles, highway transport equipment	0.0	0.0	0.0	0.2
Sea transport equipment and its repair	0.0	0.0	0.0	0.0
Airplanes, rockets, and repair	0.0	0.0	0.0	0.0
Railroad equipment and its repair	0.0	0.0	0.0	0.0
Recycling	0.0	0.0	0.0	0.0
Electric, gas, and water utilities	1.3	1.3	1.3	1.4
Construction	0.0	0.0	0.0	0.0

Wholesale and retail trade	0.0	0.0	0.0	0.0
Hotels and restaurants	0.1	0.1	0.1	0.3
Transport and storage	0.3	0.6	0.3	1.2
Communication	0.0	0.0	0.0	0.0
Finance and insurance	0.5	0.6	0.5	0.6
Real estate	9.1	9.8	8.9	10.7
Equipment rental	0.0	0.0	0.0	0.0
Computing service	0.0	0.0	0.0	0.0
Research and development	14.6	13.2	9.1	8.6
Other business services	0.0	0.0	0.0	0.0
Government, defense, social insurance	52.5	53.5	41.5	39.9
Education	8.7	8.2	14.0	12.1
Health services	11.2	10.5	17.8	15.1
Other social and personal services	0.9	1.6	5.7	9.2

SHARE OFTOTAL INVESTMENT, % (constant prices)				
	1980	1990	1998	2006
Agriculture	0.1	0.2	-0.2	0.0
Petroleum extraction	0.0	0.0	0.0	0.0
Natural gas extraction	0.0	0.0	0.0	0.0
Coal mining	0.0	0.0	0.0	0.0
Other Fuels, incl. nuclear	0.0	0.0	0.0	0.0
Ores and other mining	0.0	0.0	0.0	0.0
Food, beverages, tobacco	0.0	0.0	0.0	0.0
Textiles, apparel, leather	0.0	0.0	0.0	0.0
Wood and wood products	0.0	0.0	0.0	0.0
Paper and printing	0.0	0.0	0.1	0.1
Petroleum refining	0.0	0.0	0.0	0.0
Chemicals	0.0	0.0	0.0	0.0
Pharmaceuticals	0.0	0.0	0.0	0.0
Plastic products	0.0	0.0	0.0	0.0
Stone, Clay, and Glass products	0.0	0.0	0.0	0.0
Ferrous metals	0.0	0.0	0.0	0.0
Non-ferrous metals	- 0.0	0.0	0.0	0.0
Fabricated metal products	0.5	0.6	0.5	0.5

Machinery	20.3	21.9	18.0	18.2
Computers, office machinery	1.8	1.8	1.1	0.8
Electrical apparatus	1.3	1.5	1.4	1.5
Radio, television, communication equipment	0.6	0.8	1.0	1.5
Medical, optical, and precision instrument	0.7	1.0	1.8	3.2
Automobiles, highway transport equipment	4.3	4.6	3.8	3.6
Sea transport equipment and its repair	0.4	0.5	0.5	0.6
Airplanes, rockets, and repair	3.5	3.4	2.2	1.3
Railroad equipment and its repair	0.9	1.2	1.5	2.1
Recycling	0.6	0.6	0.4	0.3
Electric, gas, and water utilities	0.0	0.0	0.0	0.0
Construction	57.6	55.1	59.3	60.9
Wholesale and retail trade	1.9	1.9	2.8	2.7
Hotels and restaurants	0.0	0.0	0.0	0.0
Transport and storage	0.4	0.4	0.6	0.6
Communication	0.0	0.0	0.0	0.0
Finance and insurance	0.0	0.0	0.0	0.0
Real estate	0.1	0.1	0.2	0.2
Equipment rental	0.0	0.0	0.0	0.0
Computing service	0.0	0.0	0.0	0.0
Research and development	4.9	4.4	5.1	2.0
Other business services	0.0	0.0	0.0	0.0
Government, defense, social insurance	0.0	0.0	0.0	0.0
Education	0.0	0.0	0.0	0.0
Health services	0.0	0.0	0.0	0.0
Other social and personal services	0.0	0.0	0.0	0.0

SHARE OF TOTAL EXPORTS, % (constant prices)				
	1980	1990	1998	2006
Agriculture	9.5	3.5	0.8	6.5
Petroleum extraction	15.5	13.9	13.8	13.7

Natural gas extraction	0.6	1.7	2.0	1.1
Coal mining	0.4	0.6	0.5	0.9
Other Fuels, incl. nuclear	0.0	0.0	0.0	0.0
Ores and other mining	1.0	1.4	2.7	2.1
Food, beverages, tobacco	3.2	2.6	2.0	2.9
Textiles, apparel, leather	3.0	2.7	0.8	0.9
Wood and wood products	0.4	0.4	0.6	0.9
Paper and printing	0.7	0.7	1.1	1.3
Petroleum refining	6.0	6.2	7.0	5.5
Chemicals	0.9	1.2	3.3	4.1
Pharmaceuticals	0.0	0.1	0.2	0.2
Plastic products	0.3	0.3	0.7	0.7
Stone, Clay, and Glass products	0.8	0.9	0.4	0.4
Ferrous metals	4.0	4.8	8.1	5.5
Non-ferrous metals	- 1.9	3.9	8.6	7.2
Fabricated metal products	0.5	0.6	0.3	0.3
Machinery	3.7	4.0	2.3	2.0
Computers, office machinery	0.2	0.2	0.1	0.1
Electrical apparatus	1.1	1.3	0.8	0.9
Radio, television, communication equipment	0.4	0.5	0.4	0.6
Medical, optical, and precision instrument	0.0	0.0	0.1	0.1
Automobiles, highway transport equipment	2.7	3.0	1.7	1.5
Sea transport equipment and its repair	0.5	0.6	0.5	0.5
Airplanes, rockets, and repair	4.8	4.8	2.2	1.2
Railroad equipment and its repair	0.2	0.3	0.3	0.4
Recycling	0.2	0.2	0.1	0.0
Electric, gas, and water utilities	0.3	0.4	0.4	0.3
Construction	0.3	0.2	0.1	0.1
Wholesale and retail trade	28.5	29.0	27.9	27.6
Hotels and restaurants	0.1	0.1	0.1	0.1
Transport and storage	4.7	5.5	5.1	4.1
Communication	0.3	1.0	1.6	3.1

Finance and insurance	1.2	1.3	1.1	1.2
Real estate	1.5	1.6	1.6	1.7
Equipment rental	0.1	0.1	0.1	0.1
Computing service	0.1	0.1	0.1	0.1
Research and development	0.1	0.1	0.1	0.0
Other business services	0.0	0.0	0.0	0.0
Government, defense, social insurance	0.2	0.2	0.2	0.2
Education	0.0	0.0	0.0	0.0
Health services	0.0	0.0	0.0	0.0
Other social and personal services	0.0	0.0	0.0	0.0

SHARE OF TOTAL IMPORTS, % (constant prices)				
	1980	1990	1998	2006
Agriculture	2.5	2.0	2.2	4.2
Petroleum extraction	1.8	1.2	1.4	0.2
Natural gas extraction	0.1	0.7	0.9	0.3
Coal mining	0.4	0.2	0.1	0.2
Other Fuels, incl. nuclear	0.0	0.0	0.0	0.0
Ores and other mining	2.2	2.4	2.0	0.9
Food, beverages, tobacco	9.5	6.6	12.9	11.9
Textiles, apparel, leather	19.9	16.4	15.4	17.0
Wood and wood products	0.8	0.8	0.6	0.9
Paper and printing	4.0	3.4	2.3	3.1
Petroleum refining	3.0	3.8	0.6	0.4
Chemicals	2.7	3.2	3.2	3.4
Pharmaceuticals	1.2	1.5	1.6	1.9
Plastic products	2.5	2.9	2.4	1.8
Stone, Clay, and Glass products	0.7	1.1	1.6	0.9
Ferrous metals	4.5	4.1	6.7	2.7
Non-ferrous metals	– 4.9	6.2	1.8	1.1
Fabricated metal products	1.6	1.9	1.9	2.3
Machinery	8.7	10.4	10.5	11.6
Computers, office machinery	1.2	1.3	1.0	0.7
Electrical apparatus	1.5	1.8	1.9	2.6

Radio, television, communication equipment	0.7	1.0	1.5	2.6
Medical, optical, and precision instrument	0.4	0.6	1.1	2.2
Automobiles, highway transport equipment	5.9	6.7	6.3	7.4
Sea transport equipment and its repair	0.5	0.6	0.7	1.0
Airplanes, rockets, and repair	4.2	4.5	3.2	2.4
Railroad equipment and its repair	0.5	0.7	0.9	1.6
Recycling	1.2	1.4	1.1	0.9
Electric, gas, and water utilities	0.1	0.1	0.1	0.1
Construction	1.1	0.9	0.7	0.6
Wholesale and retail trade	4.6	4.0	4.4	3.9
Hotels and restaurants	0.1	0.1	0.1	0.1
Transport and storage	3.3	3.4	3.8	3.8
Communication	0.2	0.6	1.1	2.5
Finance and insurance	1.6	1.4	1.4	1.3
Real estate	0.5	0.6	0.5	0.4
Equipment rental	0.1	0.1	0.1	0.1
Computing service	0.0	0.0	0.0	0.0
Research and development	0.0	0.0	0.0	0.0
Other business services	0.1	0.1	0.1	0.2
Government, defense, social insurance	0.9	1.3	1.0	0.5
Education	0.2	0.2	0.2	0.1
Health services	0.0	0.0	0.0	0.0
Other social and personal services	0.0	0.0	0.2	0.1

DOUBLE TROUBLE: THE PROBLEM WITH DOUBLE DEFLATION OF VALUE ADDED AND AN INPUT-OUTPUT ALTERNATIVE WITH AN APPLICATION TO RUSSIA

Clopper Almon[1]
University of Maryland

Introduction

Many, perhaps all, statistical offices prepare constant-price value added for various economic sectors (or «industries») by the double-deflation method. These figures are then used to study productivity changes in the different sectors. I have long argued that this method makes no economic sense and can lead to ridiculous results. Indeed, I know of no defensible way to measure productivity gains within a single industry. It is, however, possible to measure changes in the efficiency of the whole economy in producing various products for final demand. This note explains and illustrates the problem with double deflation, describes the input-output based alternative, and applies it to the Russian economy in the period 1980-2006 on the basis of a remarkable data set developed by Marat Uzyakov and described in another contribution in this book. The application portion of the paper should be thought of as an internal discussion paper within the international Inforum group.

1. The Problem Double Deflation was Supposed to Solve

Economic progress depends on increases in productivity, so there is naturally a desire to identify the industries in which it is occurring and to measure its growth in those industries. Simple measures such as (a) industry output in constant prices divided by labor input in hours or (b) industry output in constant prices divided by all value added in the industry deflated by the GDP deflator fail to deal with the possibly important phenomenon

[1] This paper for the 2008 Inforum World Conference is a continuation of work begun in May of this year when I had the privilege to be the guest of the Institute of Economic Forecasting of the Russian Academy of Sciences. The data used was developed by Marat Uzyakov of that Institute. I am solely responsible for the opinions and the calculations. They have NOT been reviewed by Uzyakov or others of that institute.

Maurizio Grassini and Rossella Bardazzi (edited by), *Energy Policy and International Competitiveness*,
ISBN 978-88-6453-040-6 (print) ISBN 978-88-6453-043-7 (online)

of out sourcing. For example, in a base year, television sets may have been built in a factory that made the cabinet, the tube, and the electronics. In a later year, the typical TV factory may have bought the cabinet, tube, and electronics, and merely assembled the unit. If we measured the productivity by just the gross output divided by the primary inputs, we would find a large increase in productivity, which would be totally misleading. The use of intermediate inputs must somehow be taken into account in measuring productivity. Double deflation is one attempt to do so.

2. Double-Deflation and its Problems

To get double-deflated value added, one deflates the output of a sector and then from it subtracts the deflated value of intermediate inputs. (If there is no input-output table for the year in question or if current-price value-added data is not consistent with the input-output table, the method is modified to fit the situation. We will assume the ideal case of an available, matching input-output table and ignore these modifications.) The tables on the following page illustrate the method applied in three different cases. In all cases, we assume an economy with two sectors with production and consumption functions of the Cobb-Douglas form so that, as prices change, the nominal shares of each input remain constant, as do their shares in final demand. The first table shown can therefore characterize the economy in both year 1 and year 2. We may let both prices be 1.0 in year 1.

In Case 1, both prices fall to 0.5 in year 2. The first table under this case shows the first year's table deflated to prices of the second year, while the second table shows the second year's table in prices of the first year. Whichever deflated table we use, we find that real value added has doubled in each industry. This is clearly the right answer for this case.

In Case 2, the price of product 1 rises to 1.1 while that of product 2 falls to .9 in year 2. In this case, as in most cases of differing rates of change of the prices, the growth ratio for double-deflated value added depends upon whether one deflates year 1 by prices of year 2 (Paasche indexes) or year 2 with prices of year 1 (Laspeyers indexes). The usual resolution is to determine the growth ratio as the geometric mean of the two. These means are shown in the last line of the case. In year 2, «real» GDP originating in sector 1 falls to 79 percent of its value in year 1, while it rises in sector 2 to 127 percent of its base year value. I shall argue that, already in this case, these growth rates are nonsense, statistical muck, although that fact is not yet patently obvious.

In Case 3, the price of product 1 rises to 2.0 while that of product 2 falls to 0.5 in year 2. Year 1 in prices of year 2 shows negative value added in sector 2, while year 2 in prices of year 1 shows negative value added

These examples assume a Cobb-Douglas production function so that
nominal shares remain constant as prices change.
Input-Output Table in current prices for both year 1 and year 2.

	Sector 1	Sector 2	Final demand	Output	Prices
Sector 1	0.0	40.0	60.0	100.0	1.0
Sector 2	40.0	0.0	60.0	100.0	1.0
Value added	60.0	60.0			

Case 1: In year 2, both prices fall to .5

Table for year 1, prices of year 2					
Sector 1	0.0	20.0	30.0	50.0	0.5
Sector 2	20.0	0.0	30.0	50.0	0.5
DD Value added	30.0	30.0			
VA growth ratio	2.0	2.0			
Table for year 2, prices of year 1					
Sector 1	0.0	80.0	120.0	200.0	
Sector 2	80.0	0.0	120.0	200.0	
DD Value added	120.0	120.0			
VA growth ratio	2.0	2.0			
GeoMeanRatio	2.0	2.0			

Case 2: In year 2, price of product 1 rises to 1.10; price of product 2 falls to 0.90

Table for year 1, prices of year 2					
Sector 1	0.0	44.0	66.0	110.0	1.1
Sector 2	36.0	0.0	54.0	90.0	0.9
DD Value added	74.0	46.0			
VA growth ratio	0.81	1.30			
Table for year 2, prices of year 1					
Sector 1	0.0	36.4	54.5	90.9	1.1
Sector 2	44.4	0.0	66.7	111.1	0.9
DD Value added	46.5	74.7			
VA growth ratio	0.77	1.25			
GeoMeanRatio	0.79	1.27			

Case 3: In year 2, price of product 1 doubles, of product 2, falls to .5

Table for year 1, prices of year 2					
Sector 1	0.0	80.0	120.0	200.0	2.0
Sector 2	20.0	0.0	30.0	50.0	0.5
DD Value added	180.0	-30.0			
VA growth ratio	0.33	-2.00			
Table for year 2, prices of year 1					
Sector 1	0.0	20.0	30.0	50.0	2.0
Sector 2	80.0	0.0	120.0	200.0	0.5
DD Value added	-30.0	180.0			
VA growth ratio	-0.50	3.00			
GeoMeanRatio	0.41 *i*	2.45 *i*			

in sector 1. The geometric mean growth ratio of double-deflated value added for sector 1 is 0.41i and for sector 2, 2.45*i*, where *i* is the unit imaginary number, the square root of -1 in the complex numbers. I must emphasize that this case is developed in the framework most commonly used for illustrations of production functions. In fact, it is not necessary to go to such extreme price differences to get imaginary growth ratios; our example gives them when the price of product 1 goes up to 1.6 and that of product 2 falls to 0.62 in the second year. Anyone who believes that double deflation is an appropriate way to deflate value added should be prepared to explain the economic meaning of these imaginary growth ratios. I would rather not have to do so.

In my own view, the imaginary growth rates are only the *reductio ad absurdum* of a method that makes no sense no matter how small the price changes. The first consideration is the matter of *units*. Some operations with input-output tables make sense with all of the products measured in physical units. Leontief himself liked to think in physical units and often asked speakers in his seminar to give examples in physical units. The column sums of a table in physical units, however, make no sense whatsoever. When we put a flow table of one year, say t, into prices of some other year, say T, we are essentially putting the table into physical units. The unit for each row is how much a dollar (or euro, or ruble, or other currency unit) would have bought of the product in that row in year T. The column sums of such a table are therefore conceptually suspect. The sum of column j tells us how much the inputs bought by industry j in year t would have cost in year T, but that magnitude has no necessary relation to output of j in year t measured in prices of year T. The first may be less than, equal to, or greater than the second, as shown in our examples. No economic significance can therefore be attached to their difference. But that difference is precisely the double-deflated value added.

Another way to see the fallacy of double deflation is to consider the case in which the primary inputs can be deflated. Suppose there is only one primary input, labor, and that all value added is payment to labor, and that there is a good deflator for labor. We could then add labor to the list of inputs and subtract the total cost of all inputs in year t, measured in prices of year T, from the output in year t, measured in prices of year T. Clearly, there is no reason to expect that this difference should be zero. It is not the return to any factor, because all factors have been accounted for. It is just statistical muck. Suppose that we now add to this muck the return to labor. But muck + anything = muck. Thus double-deflated value added is always muck.

The lamest defense of double deflation is to say that if it is done in small steps, the imaginary growth ratios do not in practice appear. Of course they don't; the nonsense of any ridiculous method will not appear if the changes are minute.

Double deflated value added is a statistic which should never be calculated; and, if calculated, should not be released; and, if released, should never be used if there is anything more reasonable available.

Nevertheless, the deflated output which goes into the computation of deflated value added is an important statistic and should be calculated and released.

3. *The Input-Output Alternative to Double Deflation*

If there is a satisfactory way to pinpoint productivity change in specific industries, I do not know what it is. There is, however, a way to identify productivity change in the way the *whole economy* makes a particular product. We just need to calculate how many resources go into delivering one unit of each product to final demand in each year. The unit of product should, of course, be the same in all years.

To explain the calculation, we need a bit of notation. For each year t, t = 0, ..., T, let:

A_t be the input-output coefficient matrix of year t,
v_t be the vector of real input per unit of output in year t,
p_t be the vector of prices in year t; in year 0, all prices are 1.0.

Now recall that column *j* of the Leontief inverse, $(I - A)^{-1}$, shows the outputs necessary, directly and indirectly, to produce one unit of final demand of product *j*. Thus

$$x_t = v_t'(I - A_t)^{-1}$$

is the vector of real inputs per unit of final demand produced in year t. The unit of final demand, however, is the output of one currency unit (ruble, dollar, euro, and so on) of the product. This unit gets smaller as prices increase, so to convert the x vector to a constant unit, we need to multiply it element-by-element by the price index vector. Thus

$$z_t = x_t \star p_t$$

will give the desired vector of real inputs needed to produce a (constant-sized) unit of final output of each problem.

Increasing productivity in producing the final demand is indicated by a *decline* in the resources necessary to produce it.

These calculations assume that imports are made with the same input patterns as the domestic product. This assumption could be replaced with the assumption that imports are produced with exports, but that has not been done here.

Notice that this method fully takes into account changes in the input output coefficients. It would make perfect sense if all or some products in the input-output table were measured in physical units – as indeed they are when we put the table of year 2 into prices of year 1. It takes into account increased labor productivity and changes in capital intensity. It makes no use of adding up numbers in different units.

4. Application to Russia

The data set mentioned above contains 44-sector input-output tables for the period 1980-2006. Given this set of comparable tables in current prices, the main problem in the application of the method described above lies in determining real inputs. My idea was to begin by determining the total employment in the economy and to increase it by the ratio of total value added to wages plus half of mixed income. Thus, we assume that employment represents the real input of labor while the rest of value added represents the real input of capital and other factors. In principle, this employment should be adjusted for quality, but I have made no such adjustment in the calculations shown here. These total real resources were then allocated among industries in each year in proportion to value added in that year.

Most of the peculiarities in the results stem from the inadequacies of this procedure. I have taken the capital input to be gross profits. But in some cases, profits were negative. Surely, that does not mean that the input of capital was negative. A measure of capital input on the basis of the capital stock would give more reasonable and stable results. Taxes on products are a somewhat peculiar primary input, all the more so when they are negative, representing subsidies. Because of these peculiarities of profits and taxes, a second computation was made using only compensation of employees plus mixed income to distribute employment among industries. In the graphs shown below, the results of the first computation are shown by the (red) line marked by + signs, while the second are shown by the (blue) line marked by squares. Both have been normalized to be 100 in the year 2000. Many of the series showed a substantial discontinuity in 1995, the year of an input-output table important for the construction of the subsequent tables. For this reason, the graphs have been limited to the period beginning in 1995, where the data seems fairly consistent from year to year. 1995 is also the first year for which we have direct information on employment. Data for earlier years was based on population in the working age groups.

Many products showed an upward jump in resource requirements to produce a unit of final demand - a negative change in productivity - after the end of the Soviet Union, and even after 1995. That result came about because output fell faster than employment in many industries.

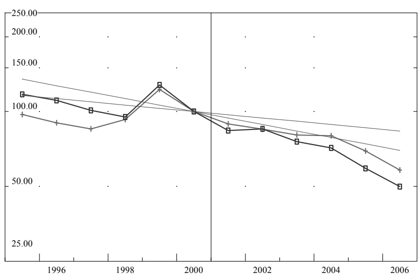
Beginning about 1999, most products begin to show steady declines in resource requirements.

For reference, lines showing a 3 percent per year and a 6 percent per year decline have been included in the graphs, which use a logarithmic vertical scale.

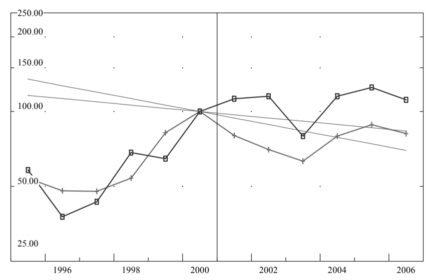
In the 2000–2006 period, most products showed fairly high rates of reduction of input requirements. The fastest growth in productivity was in Communications (9.2 per cent per year), Business services (6.5), Construction (4.7), and Agriculture (4.3). Between 3 and 4 percent per year were Trade, Computers, Real estate, Hotels and restaurants, Electrical appliances, Fabricated metal products, Ships, and Aircraft. Productivity in automobiles rose at 2.8 percent per year. Generally, the reduction in resource use based on all components of value added was faster than that based only on wage and mixed income.

While not without problems in implementation, the resource content of final demand approach to productivity measurement seems to offer a feasible and certainly conceptually superior alternative to the currently dominant double-deflated value added method.

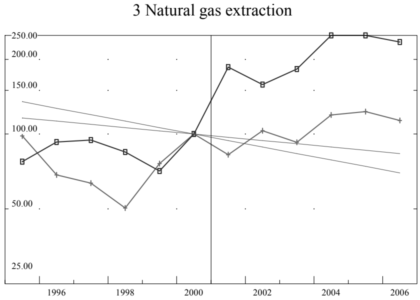
1 Agriculture



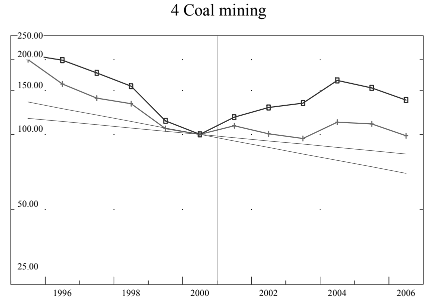
2 Petroleum extraction



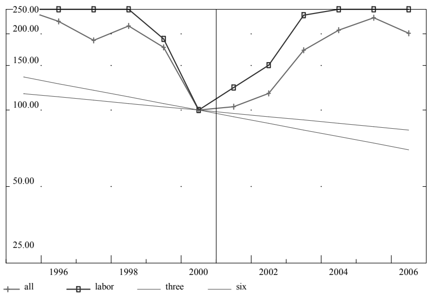
3 Natural gas extraction



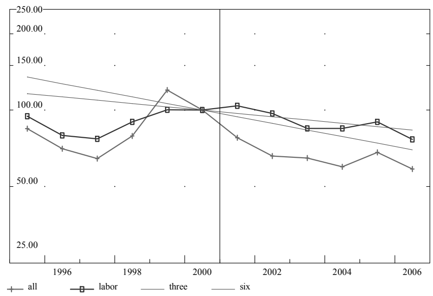
4 Coal mining



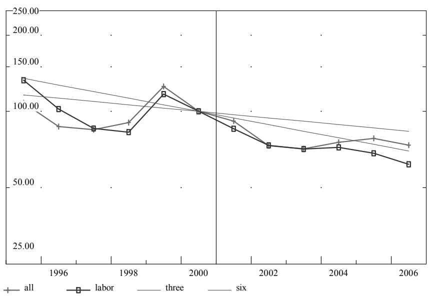
5 Other Fuels, incl. nuclear



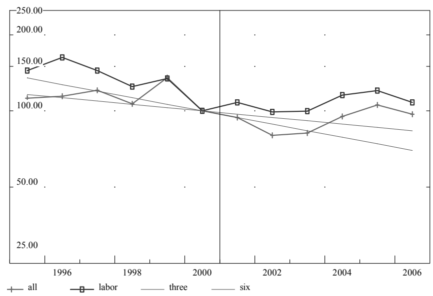
6 Ores and other mining



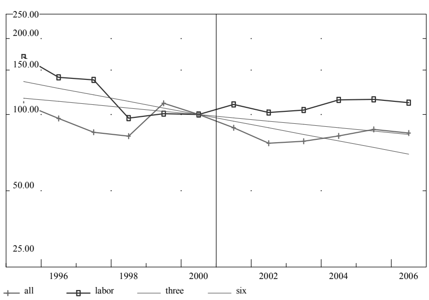
7 Food, beverages, tobacco



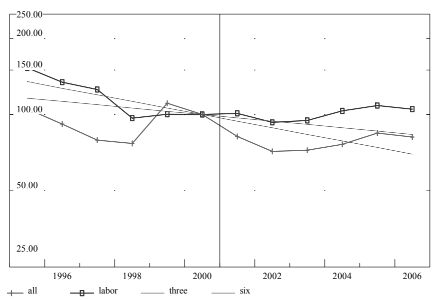
8 Textiles, apparel, leather



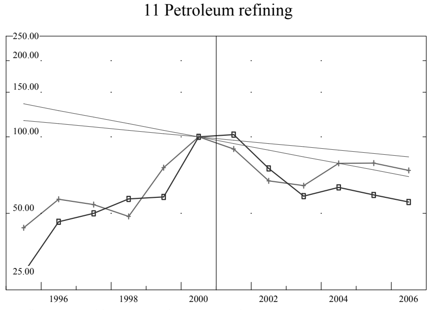
9 Wood and wood products



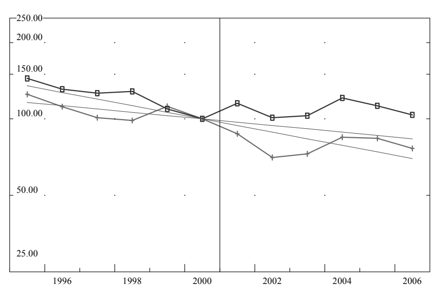
10 Paper and printing



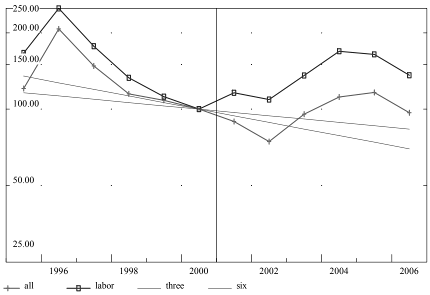
11 Petroleum refining



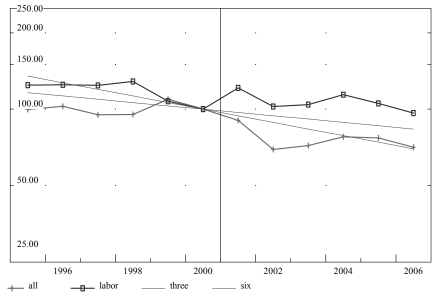
12 Chemicals



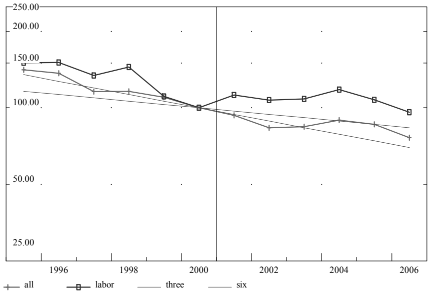
13 Pharmaceuticals



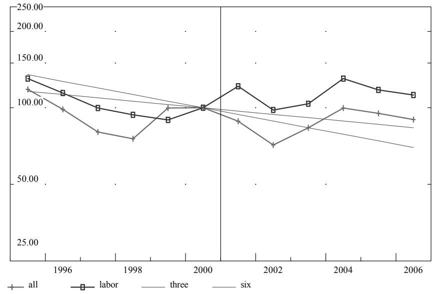
14 Plastic products



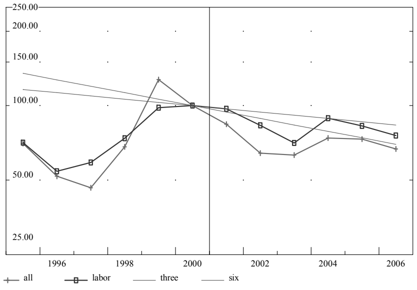
15 Stone, Clay, and Glass products



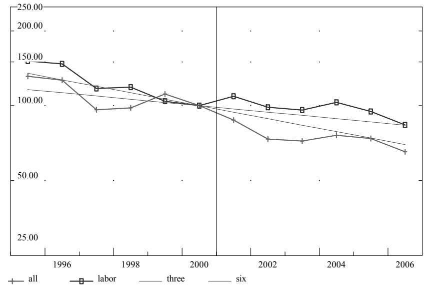
16 Ferrous metals



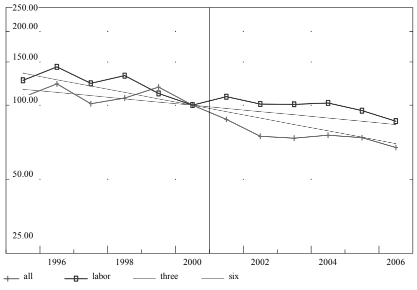
17 Non-ferrous metals



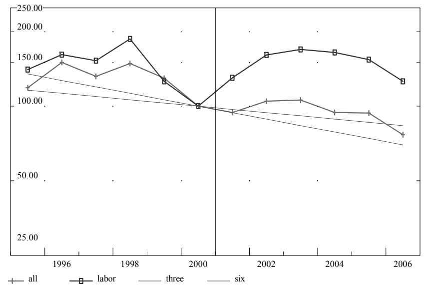
18 Fabricated metal products



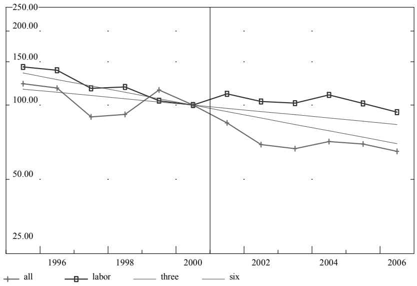
19 Machinery



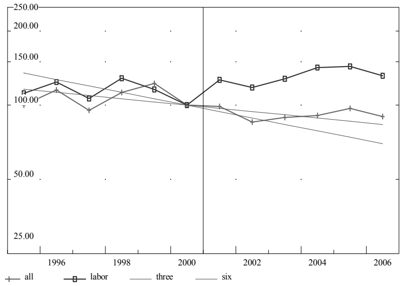
20 Computers, office machinery



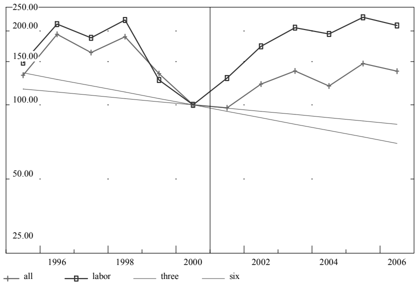
21 Electical apparatus



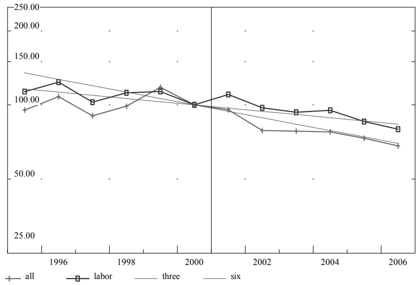
22 Radio, television, communication equipment



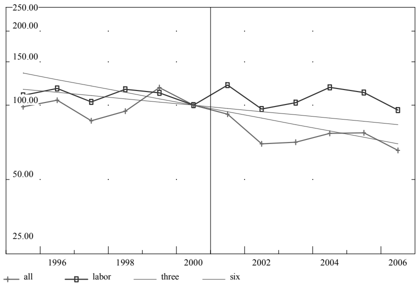
23 Medical, optical, and precision instruments



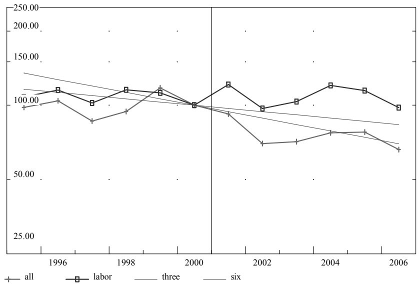
24 Automobiles, highway transport equipment



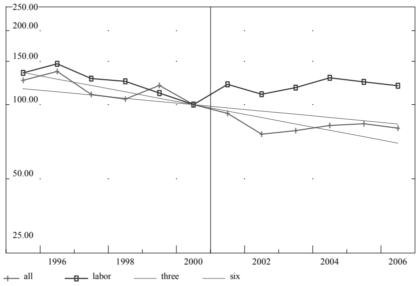
25 Sea transport equipment and its repair



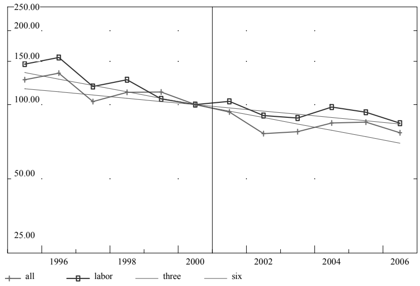
26 Airplanes, rockets, and repair



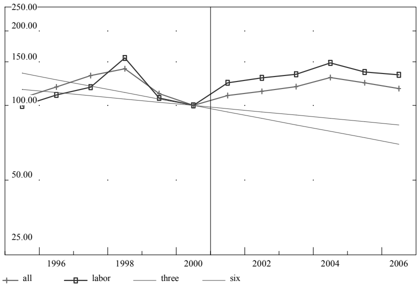
27 Railroad equipment and its repair



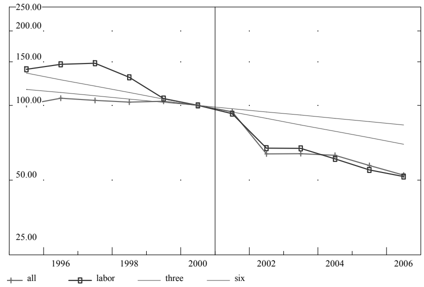
28 Recycling



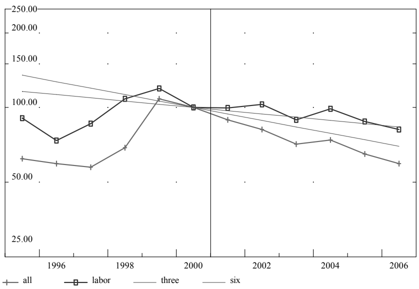
29 Electric, gas, and water utilities



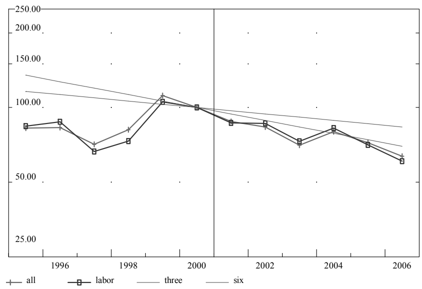
30 Construction



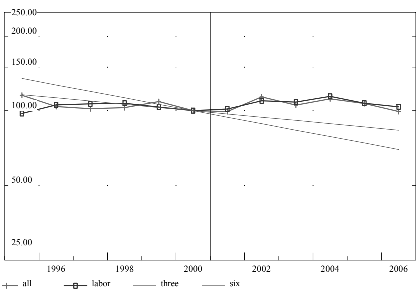
31 Wholesale and retail trade



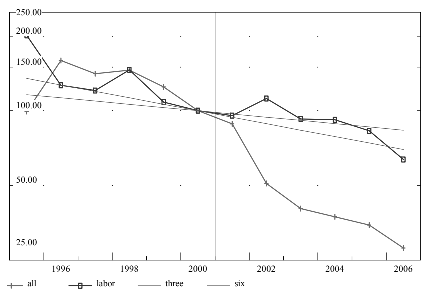
32 Hotels and restaurants



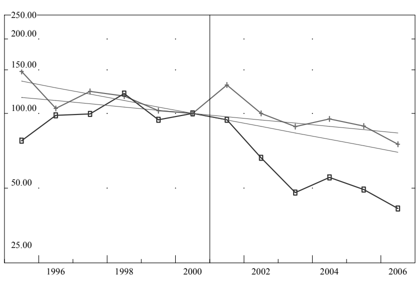
33 Transport and storage



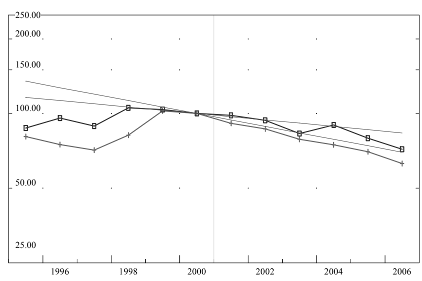
34 Communication



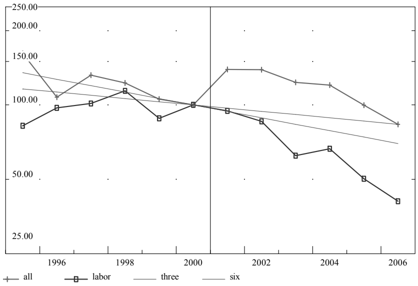
35 Finance and insurance



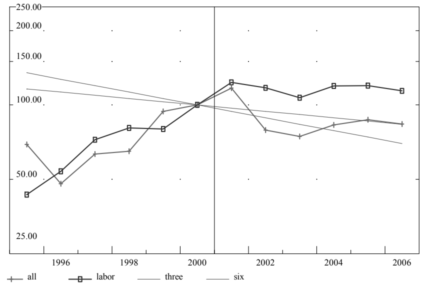
36 Real estate



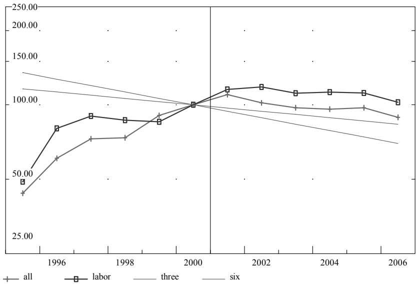
37 Equipment rental



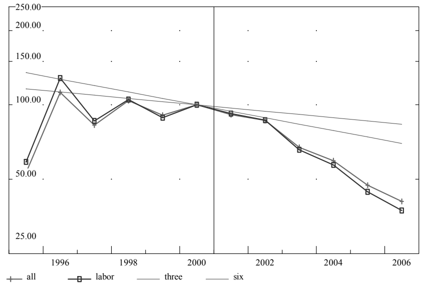
38 Computing service



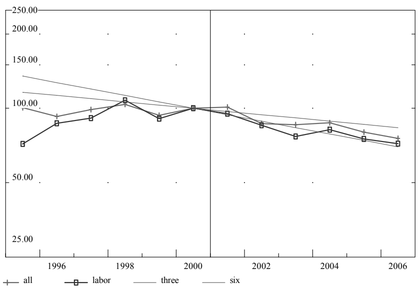
39 Research and development



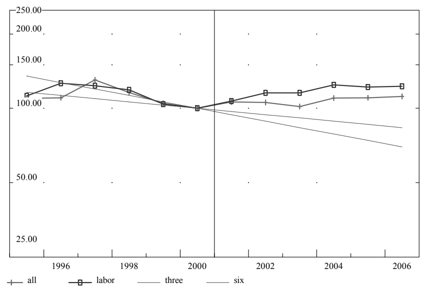
40 Other business services



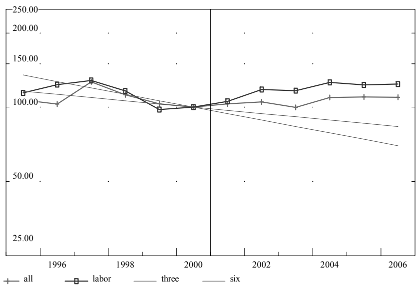
41 Government, defense, social insurance



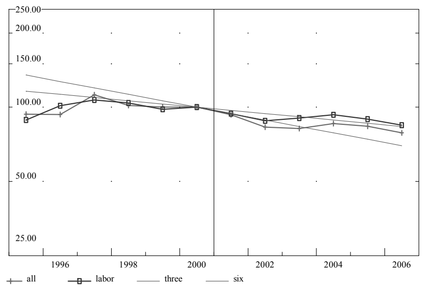
42 Education



43 Health services



44 Other social and personal services



THE INCONSISTENCY OF STABILITY AND GROWTH PROGRAMMES EVALUATED BY MEANS OF THE EU27 BILATERAL TRADE TOOL

Maurizio Grassini
University of Florence, Italy

1. *Introduction*

According to the Treaty of Rome, the task of the Community is to establish a common market and an economic and monetary union through the harmonious, balanced and sustainable development of economic activities. In the light of this principle, the Central Eastern European enlargement was generally considered risky or downright unaffordable. Later, in the nineties, the Central and Eastern candidate countries were considered a modest market area for the EU15[1] while they were expected to generate remarkable impact on the EU budget, due to the cohesion funds to be directed towards such poor economies. However, political reasons prevailed and the enlargement began its roadmap as part of the programme called Europe Agreements, defined by the European Council in 1994.

The percentage of EU12[2] of the EU population is about 21%. Given the principle of harmonious, balanced and sustainable development of the Member State's economic activities, this share may be assumed to be a good approximation of the expected EU12 market size within EU27.

Since the beginning of negotiations, the enlargement implied a redefinition of the common market area and a creation of trade previously experienced during the sixties by the EU6[3] was expected. Table 1 shows two indexes relating to international trade in the last decade. The first index is the share of exports out of the EU27, namely towards the Rest of the World. It shows that since 1999, exports directed

[1] EU15 is the Member States group before Eastern enlargement: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Portugal, The Netherlands, United Kingdom, Spain, Sweden.

[2] EU12 refers to Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia.

[3] EU6 is the group of the countries which signed the treaty of Rome in 1957: Belgium, France, Italy, Luxembourg, (West) Germany, The Netherlands.

Maurizio Grassini and Rossella Bardazzi (edited by), *Energy Policy and International Competitiveness*,
ISBN 978-88-6453-040-6 (print) ISBN 978-88-6453-043-7 (online)

out of EU27 have remained constant at around one-third of the EU27 Member States' total exports. The second index shows the percentage of EU12 exports of the EU27 exports within the EU union. This index shows the increasing export performance of the new EU Member States; it indirectly shows how the Central and Eastern European economies are catching up.

If 'a harmonious, balanced and sustainable development of economic activities' is the guiding principle of the European Union's economic policy and a country's economic size may be measured by the population, then while trade diversion related to the membership of Central and Eastern European countries may have reached its equilibrium, export penetration still seems to be surging ahead towards an expected share of 20%.

Table 1. Two indicators of EU27 and EU12 exports.

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Percentage of EU27 exports out of the European Market	32,0	33,0	33,8	33,4	32,4	32,5	33,2	32,8	33,4	34,0
Share of the EU12 exports in EU27 market	9,4	10,0	10,3	10,9	11,5	13,4	14,2	15,2	16,2	17,0

Source: Comext

The trade flows between EU Member States are analyzed here using the updated and enlarged Bilateral Trade Tool (BTT) based on Comext statistics. The basic structure of BTT is described in Grassini, Parve (2007). This Tool follows the commodity detail adopted by Ma (Ma 1996) for the Bilateral Trade Model (BTM) which links the Inforum system of country models. The present version of BTT includes a number of candidates about to join the European Union.

As well as country sectoral forecasts based on specific scenarios for each country in the EU27 BTM, this paper presents trade flows implied by the Stability and Growth Programmes and Convergence Programmes prepared by each EU Member State. First, a description of the background which led the European Union to introduce a framework of multilateral surveillance and the definition of the content and the role of such Programmes is outlined. Then, taking the macroeconomic forecast assumed by each EU Member State in these Programmes, the export forecasts implied by the import shares in EU27 BTM are computed.

2. The Stability and Growth Pact within the European Union economic policy[4]

The Stability and Growth Pact (SGP) is based on the objective of sound government finance as a means of strengthening the conditions for price stability and for strong sustainable growth conducive to creating employment. The SGP aims to strengthen the surveillance of European Union Member States' budgetary positions and the co-ordination of their economic policies. In particular, it aims to adhere to a medium term objective of a budgetary position of 'close to balance or in surplus' to which Member States are committed. Furthermore, in the case that information indicating actual or expected significant divergence from the medium term budgetary is going to occur, the SGP defines actions to alert Member States at an early stage, of the need to take necessary budgetary corrective action in order to prevent a government deficit becoming excessive.

According to the SGP, Member States are divided in two groups: those adopting the single currency, which are called 'participating Member States', and those which are 'non-participating'. The first group must submit medium term programmes called 'stability programmes'; the second group, which has not (yet) adopted the single currency, needs in any case to pursue policies aimed at a high degree of sustainable convergence, so these Member States too must submit a medium term programme called the 'convergence programme'.

Participating Member States are monitored under the monetary policy guidelines (regarding inflation and exchange rate targets); non-participating countries which have a central exchange rate *vis-à-vis* the euro, must provide a reference point for judging the adequacy of their policies; however, for all non-participating Member States their convergence programmes must be directed at avoiding real exchange rate misalignment and excessive nominal exchange rate fluctuations.

The Stability and Convergence Programmes provide the basic information for supporting surveillance and co-ordination of the Member States' economic policies. When examining and monitoring the Stability/Convergence programmes, the Council of the European Union must take into account the relevant cyclical and structural characteristics of the economy of each Member State.

Each Stability Convergence programme must provide information on the main assumptions about expected economic development and those important economic variables which are relevant to the realization of the programme and in particular the real gross domestic product (GDP),

[4] The contents of this paragraph are largely taken from the Council Regulation (EC) No 1466/97.

employment and inflation. Such variables are the cornerstone of assessment of the budgetary and other economic measures being taken or proposed in order to achieve the objectives of the programme. Within the framework of multilateral surveillance, the European Council examines the medium term budgetary objective presented by the Member State concerned and assesses whether the economic assumptions on which the programme is based are plausible, whether the adjustment path towards the medium term budgetary objective is appropriate and whether the measures proposed are sufficient to achieve the medium term objective over the cycle.

In order to facilitate comparison across countries, Member States are expected, as far as possible, to follow a common model structure described in a 'Code of conduct' endorsed by ECOFIN[5]. The quantitative information in each Stability/Convergence Programme must be presented in a number of standardised sets of tables; however, these tables may be supplemented by further information wherever deemed useful by Member States.

Commission forecasts provide an important contribution to co-ordinating economic and fiscal policies. Anyway, Member States are free to base their Stability/Convergence Programmes on their own projections. Among the main assumptions about the expected economic developments and important economic variables relevant to the realization of their budgetary plans, GDP projections play an important role. According to the SGP regulation, the assumption of real GDP growth should be underpinned by an indicator of the expected demand contributions to growth. In the 'Code of conduct', this is accomplished by Table 2 below where Exports and Imports are among the demand contributors. Furthermore, the Stability/Convergence Programmes must provide information enabling analysis of the cyclical position of the economy and the source of potential growth.

In due time, for comparison purposes the European Commission provides 'common external assumptions' of the main extra-EU variables.

The GDP projections in Table 2 are demand oriented; they are determined by the final demand component forecasts. The information to be given in other Tables defined in the 'Code of conduct' refers to public finance revenues and expenditures, assumptions about interest rates and expected inflation rates and supply-side variable sets for calculating potential output. This set is related to the method used to calculate potential output. At the time of introduction of the Stability and Growth Pact, potential output was filtered out using the Hodrick-Prescot filter.

[5] ECOFIN is the European Council dealing with Monetary and Economic Affairs.

In order to show the supply-side determinants of potential output, the production function approach was adopted and is in the process of being applied to all Member States. This approach relies on two unobservable variables – potential output and Total Factor Productivity (TFP) – and on an assumed, not-observed, production function analytical form. Consequently, demographic projections to compute the labour force ('Labour market developments' is the title of the table from the Code of conduct) and capital formation (which necessarily relies on Gross fixed capital formation and Changes in inventories as final demand components listed in Table 2) are required data variables.

Table 2. The Table in the 'Code of Conduct' summarizing the assumptions about Real and Nominal GDP.

	ESA Code	Year X-1	Year X-1	Year X	Year X+1	Year X+2	Year X+3
		Level	rate of change	rate of change	rate of change	rate of change	rate of change
1. Real GDP	B1*g						
2. Nominal GDP	B1*g						
Components of real GDP							
3. Private consumption expenditure	P.3						
4. Government consumption expenditure	P.3						
5. Gross fixed capital formation	P.51						
6. Changes in inventories and net acquisition of valuables (% of GDP)	P.52 + P.53						
7. Exports of goods and services	P.6						
8. Imports of goods and services	P.7						
Contributions to real GDP growth							
9. Final domestic demand		-					
10. Changes in inventories and net acquisition of valuables	P.52 + P.53	-					
11. External balance of goods and services	B.11	-					

Source: Code of Conduct

The Stability/Convergence Programmes are assessed by the European Council and, if necessary, are accompanied by recommendations. Assessment takes the bureaucratic form of a Council Opinion which is supported by technical analysis of the Member State Stability/Convergence Programme prepared by the European Commission (Directorate-General for Economic and Financial Affairs (DG ECFIN). The analysis mainly takes into account (1) the Commission service' autumn forecast, (2) the 'code of conduct' and (3) the commonly agreed methodology for the estimation of potential output and cyclically-adjusted balances.

As required by the Council Regulation concerning the Stability and Growth Pact, the assessment covers a number of points; among them is the assessment of whether the economic assumptions on which the programme is based are plausible. The Commission service' autumn forecast and the 'common external assumptions' provided by the Commission should be the documents supporting the plausibility of this point. However, the surveillance on fiscal policy focuses on cyclically-adjusted balances and judgements of macroeconomic assumptions (such as those listed in Table 2) are not in first place. Furthermore, the Commission forecasts cover a shorter horizon than that required by the Stability and Growth Pact; hence, the plausibility of the economic assumptions turns out to be rather vague. It is common to find in the analysis of the update of a Stability as well as Convergence Programme the statement that it is 'broadly in line with the Commission service' autumn forecast' and that the scenario supporting the programme 'appears to be based on plausible growth assumptions'.

3. The EU27 BTT at work. Two scenarios

EU27 BTT is used to investigate trade flows between European countries and to forecast flow matrices according to specific scenarios where the countries are divided in two groups: those in the Inforum system of models (namely, Spain, France, Germany, Belgium, Austria, UK) and those not yet explicitly linked to the Inforum BTM.

The first scenario is mainly based on the Inforum BTM forecast.

For the countries in the Inforum system of models, the relative columns in the flow matrices follow the Inforum BTM forecast. For the other countries a mixed scenario is adopted; a) for the years 2007 (observed), 2008 (estimated) and 2009 (forecast) import growth rates from the Commission Autumn Forecast 2007 are applied to extend the import flows and b) from 2010 onwards the aggregate import growth rate of the countries in the Inforum system of models is applied to the other countries in the EU27 BTT.

This scenario produces a baseline forecast which, in this context, represents a neutral or more reliable forecast for EU27 countries. The forecast is considered neutral in relation to scenarios designed by the Inforum team. It is considered reliable in relation to any other scenario composed of assumptions coming from independent sources.

The second scenario introduces the forecast that each European Member State produces within the Stability and Growth Pact.

In this framework, each Member State commits to observing the medium-term budgetary objective of a position 'close to balance or in surplus' set out in the stability or convergence programmes. These programmes contain a declaration of the fiscal policy each country intends to conduct and the effects of such policy programmes are summarized in a number of tables. In accordance with the provisions of Council Regulation (EC) No 1466/97, as described above, each Member State submits a Stability or Convergence programme showing the path of the general government surplus/deficit ratio and debt ratio together with the main economic assumptions on an annual basis; these cover, as well as the current and preceding years, at least the three following years leaving it up to Member States to cover a longer period if they so wish. Table 2, shows the required variables and the highly desirable variables. GDP at constant market prices and at current market prices belongs to the set of required variables. In fact, GDP is a pivot-variable when evaluating fiscal policy programmes; the components of GDP are also required, and among them the 'external balance of goods and services' comes from the ESA code variables P6 and P7, namely exports and imports of goods and services. Tables 3 and 4 show the respective growth rates of imports and exports taken from the stability and convergence programmes of the EU27 Member countries delivered in Autumn 2007.

The import rates in Table 3 are used to forecast BTT import flow matrices. For the countries in the Inforum system of models, the structure of the forecast import flows is preserved and the total is rescaled according to the import growth rates reported in the Stability or Convergence programmes. For the countries not in the Inforum system of models, the import growth rates reported in the Stability or Convergence programmes are applied to all commodities. The growth of export flow rates corresponding to the assumed import growth rates in Table 3 and using BTT trade flows matrices are reported in Table 5. The difference between export growth rates in Table 3 and Table 5 are shown in Table 6.

Table 3. Import growth rates taken from the Stability and Growth Programmes and Convergence Programmes (ESA P7) (November 2007).

	Years	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	Austria	6,80	7,70	6,60	6,00	6,00					
2	Belgium	2,70	4,90	4,80	5,60	5,60	5,60				
3	Bulgaria	15,15	13,57	11,69	11,14	11,05					
4	Cyprus	6,80	3,30	3,10	3,50	3,50	3,60				
5	Czech Republic	15,20	13,90	12,70	12,40	12,40					
6	Germany	11,20	6,30	6,80	5,50	5,50	5,50				
7	Denmark	14,40	5,70	3,50	2,20	3,20	2,00	3,80	3,80	3,80	3,80
8	Estonia	17,10	3,50	4,70	5,90	7,30	7,50				
9	Spain	8,30	7,20	5,50	5,20	5,50					
10	Finland	8,30	4,40	3,80	3,00	2,80	2,60				
11	France	4,40	5,50	6,70	6,70	6,70	6,70				
12	UK	6,75	3,75	4,00	4,25	4,25					
13	Greece	8,70	8,40	7,80	7,20	7,00					
14	Hungary	14,50	13,20	11,10	11,00	11,10	11,10				
15	Ireland	4,40	5,90	4,50	4,30	4,10					
16	Italy	4,30	1,80	2,50	3,10	3,30	3,40				
17	Lithuania	13,80	16,00	12,30	4,10	8,40					
18	Luxenburg	7,20	9,30	7,20	8,00	7,70					
19	Latvia	17,50	22,10	8,90	7,50	7,40					
20	Malta	8,10	-3,90	2,00	2,10	1,80					
21	Netherlands	8,10	6,50	6,00	5,50	5,50					
22	Poland	17,40	10,90	9,60	7,80	7,00					
23	Portugal	4,30	3,80	3,90	4,80	5,60	6,60				
24	Romania	23,00	21,50	16,10	14,90	13,90					
25	Svezia	3,20	3,20	2,90	3,00	3,00					
26	Slovenia	12,20	14,20	10,10	8,20	8,00	7,70	7,70	7,70		
27	Slovacchia	17,80	17,20	11,50	8,10	6,10					

Table 4. Export growth rates taken from the Stability and Growth Programmes and Convergence Programmes (ESA P6) (November 2007).

	YEAR	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	Austria	8,50	7,10	6,20	6,20	6,60					
2	Belgium	2,60	4,60	4,50	5,60	5,60	5,60				
3	Bulgaria	8,96	8,70	8,95	11,22	11,61					
4	Cyprus	4,80	1,60	2,70	3,30	3,70	3,90				
5	Czech Rep.	15,90	13,20	11,90	12,90	13,50					
6	Germany	12,50	7,80	6,30	5,50	5,50	5,50				
7	Denmark	10,10	4,90	3,00	3,50	3,60	2,00	3,30	3,30	3,30	3,3
8	Estonia	8,30	2,50	6,40	7,70	7,70	7,70				
9	Spain	5,10	5,70	5,40	5,40	5,70					
10	Finland	10,40	5,70	4,70	5,00	4,50	4,00				
11	France	3,60	5,70	6,80	6,80	6,80	6,80				
12	UK	10,25	-3,25	4,75	5,00	5,00					
13	Greece	5,10	8,00	7,30	7,60	7,70					
14	Hungary	18,90	15,50	12,90	11,80	11,50	11,20				
15	Ireland	4,40	6,80	5,60	5,20	5,00					
16	Italy	5,30	2,00	2,80	3,50	3,80	4,10				
17	Lithuania	12,20	8,60	12,20	2,40	8,00					
18	Luxenburg	9,60	10,30	6,90	8,20	7,80					
19	Latvia	5,30	9,50	9,10	7,60	7,50					
20	Malta	10,00	-1,70	2,30	3,30	3,20					
21	Netherlands	7,00	6,25	6,50	5,75	5,75					
22	Poland	14,60	9,00	6,00	6,20	6,20					
23	Portugal	8,90	6,90	6,70	6,00	6,30	6,50				
24	Romania	10,60	8,30	10,30	10,90	10,70					
25	Svezia	4,20	2,70	3,20	3,20	3,30					
26	Slovenia	12,30	13,40	10,30	9,70	8,80	8,20	8,20	8,20		
27	Slovacchia	20,70	21,10	12,80	8,90	6,80					

Table 5. Export growth rates for the EU27 BTM according to PSG programme forecasts.

	YEAR	2007	2008	2009	2010	2011
1	Austria	7,68	7,18	6,62	6,43	5,78
2	Belgium	6,72	6,30	5,85	5,83	5,28
3	Bulgaria	7,99	7,21	6,70	6,10	5,13
4	Cyprus	5,56	5,41	5,34	5,34	4,20
5	Czech Republic	8,06	7,31	6,43	6,19	5,43
6	Germany	7,15	6,69	6,40	6,48	5,70
7	Denmark	6,35	5,91	5,58	5,40	4,92
8	Estonia	7,76	6,08	5,28	5,64	4,67
9	Spain	6,29	6,12	5,81	5,93	5,73
10	Finland	7,11	6,52	6,35	6,25	5,67
11	France	6,89	6,26	5,88	5,88	5,44
12	United Kingdom	6,88	6,38	5,96	5,95	5,53
13	Greece	7,49	6,60	6,33	6,04	5,12
14	Hungary	7,93	7,14	6,63	6,33	5,21
15	Ireland	6,65	6,04	5,92	6,00	5,26
16	Italy	7,55	7,06	6,61	6,33	5,92
17	Lithuania	8,32	6,37	6,02	6,14	4,99
18	Luxenbourg	10,08	9,06	7,63	7,04	6,24
19	Latvia	7,19	6,44	5,16	5,86	4,67
20	Malta	8,24	7,19	6,87	7,41	6,58
21	Netherlands	6,41	6,20	5,93	5,89	5,29
22	Poland	7,65	7,04	6,28	6,37	5,48
23	Portugal	6,50	5,90	5,73	5,83	5,47
24	Romania	7,35	6,78	6,22	5,94	5,35
25	Sweeden	6,90	6,18	5,87	5,98	5,34
26	Slovenia	7,98	6,89	6,81	5,81	5,59
27	Slovakia	8,18	7,63	7,13	7,23	5,13

Table 6. Differences of Export growth rates between EU27 exports and SCP programmes growth rates.

	YEAR	2007	2008	2009	2010	2011
1	Austria	0,58	0,98	0,42	-0,17	
2	Belgium	2,12	1,80	0,25	0,23	-0,32
3	Bulgaria	-0,71	-1,74	-4,52	-5,51	
4	Cyprus	3,96	2,71	2,04	1,64	0,30
5	Czech Republic	-5,14	-4,59	-6,47	-7,31	
6	Germany	-0,65	0,39	0,90	0,98	0,20
7	Denmark	1,45	2,91	2,08	1,80	2,92
8	Estonia	5,26	-0,32	-2,42	-2,06	-3,03
9	Spain	0,59	0,72	0,41	0,23	
10	Finland	1,41	1,82	1,35	1,75	1,67
11	France	1,19	-0,54	-0,92	-0,92	-1,36
12	United Kingdom	10,13	1,63	0,96	0,95	
13	Greece	-0,51	-0,70	-1,27	-1,66	
14	Hungary	-7,57	-5,76	-5,17	-5,17	-5,99
15	Ireland	-0,15	0,44	0,72	1,00	
16	Italy	5,55	4,26	3,11	2,53	1,82
17	Lithuania	-0,28	-5,83	3,62	-1,86	
18	Luxenbourg	-0,22	2,16	-0,57	-0,76	
19	Latvia	-2,31	-2,66	-2,44	-1,64	
20	Malta	9,94	4,89	3,57	4,21	
21	Netherlands	0,16	-0,30	0,18	0,14	
22	Poland	-1,35	1,04	0,08	0,17	
23	Portugal	-0,40	-0,80	-0,27	-0,47	-1,03
24	Romania	-0,95	-3,52	-4,68	-4,76	
25	Sweeden	4,20	2,98	2,67	2,68	
26	Slovenia	-5,42	-3,41	-2,89	-2,99	-2,61
27	Slovakia	-12,92	-5,17	-1,77	0,43	

Table 7. Percentage difference in year 2010 of EU27 exports compared to exports forecast in the Stability/Convergence programmes.

1	Austria	-1,65	15	Ireland	-1,87
2	Belgium	-4,08	16	Italy	-13,73
3	Bulgaria	12,16	17	Lithuania	3,97
4	Cyprus	-9,45	18	Luxenbourg	-0,61
5	Czech Republic	23,84	19	Latvia	8,83
6	Germany	-1,56	20	Malta	-19,51
7	Denmark	-7,53	21	Netherlands	-0,20
8	Estonia	-0,50	22	Poland	0,02
9	Spain	-1,84	23	Portugal	1,83
10	Finland	-5,83	24	Romania	13,73
11	France	1,14	25	Sweeden	-11,27
12	United Kingdom	-12,49	26	Slovenia	14,45
13	Greece	3,95	27	Slovakia	18,80
14	Hungary	24,03			

4. *Results*

Tables 6 and 7 show the results of the second scenario. Table 6 shows the differences in the export growth rates between EU27 exports and SCP programmes' growth rates. It is clear that a systematic bias differentiates the EU15 group from the EU12 group; in the old Member States group an underestimate of the rate of export growth prevails; on the contrary, new Member States declare an export performance not supported by the European foreign market represented by old and new Member States. The percentage difference between the exports forecast by the Stability or Convergence programmes and those compatible with the observed BTT trade flows are shown in Table 7. Negative values are determined by 'underestimated' exports and vice versa.

Although the mismatch largely dominates inside both EU12 and EU15, some exceptions deserve a special mention. Fig. 1-6 show that Germany and Poland do not have serious differences between the Stability or Convergence programme assumptions and BTT27 forecasts. Czech Republic and Slovakia may well be cases of clearly optimistic forecasts. The last two Figures, Estonia and Latvia, show that exports may follow different paths which, in the case of Estonia reach a level of exports not far from that assumed in the country's Convergence Programme.

Fig. 7 summarizes the simulation of exports filtered out from BTT27 and those assumed in the Stability or Convergence programmes.

Fig. 1

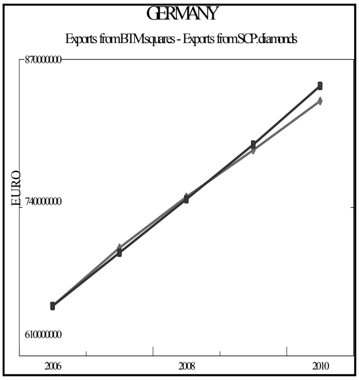


Fig. 2

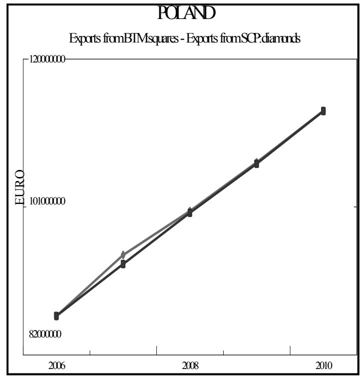


Fig. 3

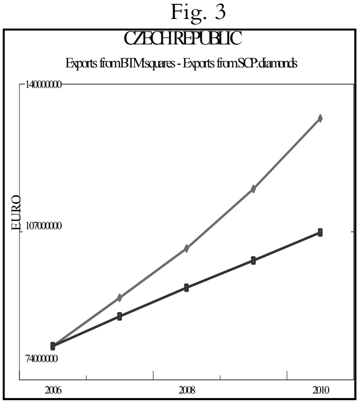


Fig. 4

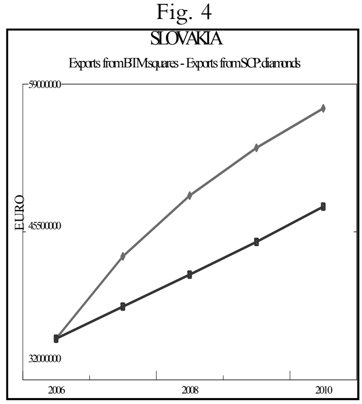


Fig. 5

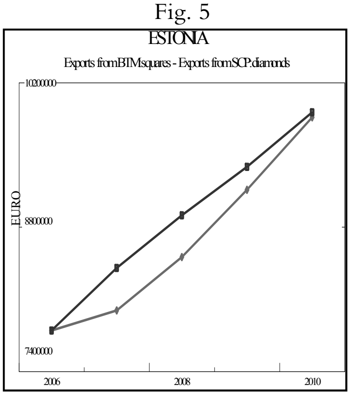


Fig. 6

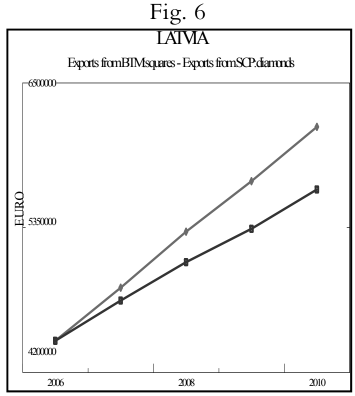
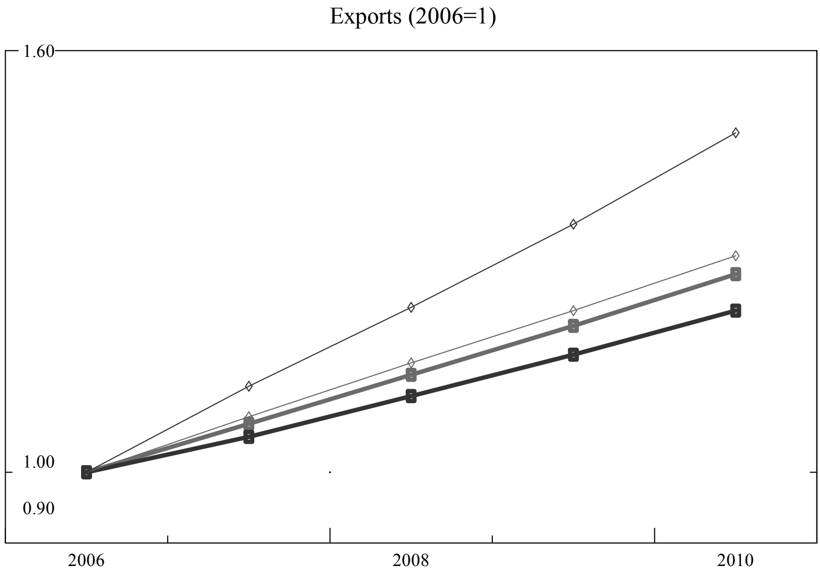


Figure 7. Export performance under PSC programmes



EU15 from EU27BTM === EU15 from SGP === EU12 from EU27BTM --- EU12 from SGP ---

5. Conclusions

As defined above, Table 6 shows the discrepancies between the assumed export growth rates declared in the Stability or Convergence programmes and those obtained 'linking' the trade flows by means of the EU27 BTT.

The European Commission carefully scrutinizes each Stability and Convergence programme and, among its judgments, the reliability of the assumptions supporting the macroeconomic forecasts is always considered; in general, such assumptions are accepted as trustworthy.

It is a matter of fact that these Stability or Convergence programmes contain demand-side forecasts and other information used to evaluate the Member State's fiscal policies, and this information consists mainly of supply-side variables. Since the surveillance focuses on fiscal policies, macroeconomic forecasts supported by demand-side assumptions may receive less attention. But, it is a matter of fact that macro-variables such as GDP (real and nominal) have significant impact or are strictly related to variables belonging to the set of those qualified as structural (potential output, labour supply, capital formation, total factor productivity).

The mismatch between Member State's demand (imports) and supply (exports) in the EU market may negatively influence each Member State's economic performance in terms of the GDP growth rate (together with other correlated macrovariables).

Furthermore, the comparison between the export growth rates contained in the Stability or Convergence programmes and those implied by the trade flow structure shown in the European foreign trade statistics (Comext) highlights that the European Commission's mutual surveillance considers each Member State separately from the rest of the European Union.

References

European Commission (2008). Economic Forecasts, Spring 2008.

European Commission (2005). Guidelines on the format and content of Stability and Convergence Programmes.

Grassini M., Parve R. (2007). A Bilateral Trade Tool for EU Countries not yet in the Inforum System. In: Plich M., Przybylinski M. (eds.), *Recent Development in Inforum-type Modeling*, Lodz University Press, Lodz.

Ma Q. (1996). A Multisectoral Bilateral World Trade Model. Ph.D. Thesis, Inforum WP #95-006, University of Maryland.