SCHRIFTEN ZUR WIRTSCHAFTSTHEORIE UND
WIRTSCHAFTSPOLITIK

Christian Schmidt

Real Convergence in the European Union

PETER LANG

SCHRIFTEN ZUR WIRTSCHAFTSTHEORIE UND WIRTSCHAFTSPOLITIK

Christian Schmidt

Real Convergence in the European Union

Over the next couple of years, the European Union will face a difficult stage, being confronted with the eventual transition to a monetary union. In the beginning of 1997, it is less clear than ever, if and when the European Monetary Union will eventually be realized, which countries will join in this process, and which countries will benefit from monetary union or are likely to loose out. Using econometric methods, the work attempts to assess the real economic effects of the European Monetary Union. In a first step, differences in labor and goods market adjustment processes between the fifteen member states of the European Union, the United States and Canada are studied in order to evaluate the short-term prospects of monetary union.Turning to the long-run effects, within a second step, convergence of living standards is assessed.

Christian Schmidt studied Economics at the University of Freiburg and at Wayne State University in Detroit. After participating in the Advanced Studies Program in International Economic Policy Research at the Kiel Institute of World Economics he began his work on this dissertation as a participant of the Europa-Kolleg in Hamburg in 1993.

Retrodigitization in 2018

Real Convergence in the European Union

Schriften zur Wirtschaftstheorie und Wirtschaftspolitik

Herausgegeben von
Rolf Hasse, Wolf Schäfer, Thomas Straubhaar und Klaus W. Zimmermann

Band 8

PETER LANG
Frankfurt am Main · Berlin · Bern · New York · Paris · Wien

Christian Schmidt

Real Convergence in the European Union

An Empirical Analysis

PETER LANG
Europäischer Verlag der Wissenschaften

Die Deutsche Bibliothek - CIP-Einheitsaufnahme

Schmidt, Christian:

Real convergence in the European Union : an empirical analysis / Christian Schmidt. - Frankfurt am Main ; Berlin ; Bern ; New York ; Paris ; Wien : Lang, 1997
(Schriften zur Wirtschaftstheorie und Wirtschaftspolitik ; Bd. 8)

Zugl.: Hamburg, Univ. der Bundeswehr, Diss., 1997
ISBN 3-631-32122-8

Gedruckt mit Unterstützung der Universität der Bundeswehr Hamburg

D 705
ISSN 1433-1519
ISBN 3-631-32122-8
US-ISBN 0-8204-3500-7
ISBN 978-3-631-75005-6 (eBook)

Printed in Germany 1 2 3 4 5 7

DEDICATION

I want to thank Professors Thomas Straubhaar and Rolf Hasse for their supervision of the dissertation. To both of them, as well as to Professor Goetz Uebe, I am indebted for helpful comments. In addition, I am grateful to my colleages at the Europa-Kolleg and the Universität der Bundeswehr Hamburg for stimulating discussions. Financial support by the German research community (Deutsche Forschungsgemeinschaft) and the Universität der Bundeswehr Hamburg was greatly appreciated. Special thanks to Louise Tracey for reviewing the English language in the dissertation. Last, but not least, thanks to Silvia Marengo for her persistent support and encouragement during difficult periods and to my parents for helping me to get on the way.

1. Introduction

Over the next couple of years, the European Union (EU) will face a difficult stage, being confronted with the eventual transition to monetary union. In the beginning of 1997, it is less clear than ever, if and when European Monetary Union (EMU) will eventually be realized and which countries will join in this process. For example, countries such as Germany and England may meet the necessary requirements, but may choose not to join. In contrast, some countries who may possibly wish to enter EMU, may not be allowed to do so.

The actual consequences of the union, if it goes ahead, are currently difficult to predict. It is far from clear whether all member states will benefit from the adoption of a single currency and, if not, which member states will do so and which ones are likely to loose out. Indeed, the member states of the European Union are structurally still quite different; for example, unemployment rates ranged from 4.4 per cent in Austria to 24.2 per cent in Spain in 1994. One reason for this dispersion in unemployment rates is that the EU countries have different wage formation mechanisms and characteristics. Under these conditions, if countries face a common demand or supply shock, different wage and price developments will result. However, a monetary union requires nominal convergence. As a result, divergence in unemployment rates, and therefore real economic divergence, may be unavoidable. Yet if the monetary union consists of countries that are structurally very different, this may threaten overall macroeconomic stability. Such a situation will imply transfers from low-unemployment (high growth) countries to high unemployment (low growth) countries. If this is of a permanent character, the willingness of the low unemployment (high growth) countries to remain within the union will be affected. In addition, an EMU consisting of very different member states may experience conflict about the purpose of monetary union. Countries with a high unemployment rate will argue for a more expansionary policy than countries with a lower one. However, in the union there can only be one single monetary policy with a single rate of inflation. These conflicts may then lead to a relatively higher rate of inflation within the union. The real effects of monetary union will largely depend on the degree of structural convergence prior to its introduction. If economies become structurally less different over time, the effects of the adoption of a single currency will be less severe.

In view of these issues, this dissertation attempts to assess empirically the

esses and, secondly, on long-run growth and convergence as indicators of real convergence. These indicators were chosen because they seemed to be the logical measures for convergence of real economic activity. In addition, most academic and political discussion concentrates on cyclical congruency and the long-run convergence of living standards. As well as providing empirical evidence on real convergence, with regard to the difficulties associated with the transition to monetary union, this work also aims to contribute to the process of European monetary integration by providing proposals for reform.

The starting point for this critique is a review of the recent monetary integration process in Europe. At the end of the 1980s new political initiatives to relaunch EMU among the member states of the EU gained momentum, culminating in the ratification of the Maastricht Treaty by the member states at the beginning of the 1990s and related to this, the plan to adopt a single currency in Europe by the end of the century. The Treaty has set out a path towards EMU following three stages, with transition to the next stage dependent on some degree of convergence being achieved in the previous stage. Economic convergence is thus considered a precondition for further moves towards economic and monetary integration. Before transition to the third and final stage, progress made in terms of economic convergence will be reassessed. Each country will be assessed individually before it is decided whether or not they can proceed into the union. The Protocol referred to in Article 109f of the Treaty sets out four criteria for transition to the third stage relating to inflation performance, budget positions, exchange rate stability and interest-rate convergence. The formulation of the convergence criteria and the gradual approach towards monetary union has been discussed both in acadamic and political circles. Chapter Two will critically assess the transition process as determined in the Maastricht Treaty. This aims to establish the economic policy background of the subsequent empirical analyses and to provide an analysis of the transition to monetary union.

In Chapter Three, the dynamics of the labor and goods market adjustment processes in Europe are analyzed. This analysis relates to the issue of whether the adoption of a common currency in Europe makes good economic sense. The economic background for this examination is derived from the theory of optimum currency areas. This theory compares the economic costs of flexible and fixed exchange rate systems. The main cost factor in a system of fixed exchange rates is the inability to adjust exchange rates in response to unanticipated disturbances. Based on this theory, it is possible to evaluate the economic costs and benefits of EMU by analyzing the dynamic adjustment processes of the economies in response to disturbances. In doing this, the dynamic interactions of output and un-

employment in the fifteen EU-countries are compared with Canada and the United States. Considering the possibility of a possible multi-speed monetary union there is also included a comparison of the symmetry of shocks across different regions within Europe.

Chapter Four reviews the theoretical and empirical literature on growth and convergence and provides an econometric analysis on convergence in the EU-countries. Disparities between income per capita across regions and countries have been a matter of concern for the European Community (EC) since its inception. The objective of reducing disparities across regions in the EC has already been established in the preamble of the Treaty of Rome. In addition, in the Single European Act of 1987, the Community was given an explicit ability to undertake regional policies aimed at reducing disparities. The issue of growth and convergence is particularly interesting and relevant within the context of European integration for two reasons. First, regional convergence or divergence influences the usefulness of regional economic policies which attempt to equalize the distribution of income and second, European monetary integration might contribute to convergence - or divergence - itself by increasing factor mobility or trade between participating countries. There are fears that a fully-fledged EMU will widen the existing regional inequalities in per capita income within the European Union. Therefore, an empirical analysis of growth and convergence is central to the real economic convergence debate.

Three modern theories of economic growth are reviewed and their implications for economic convergence summarized. Theories of technological catch-up argue that an inefficient use of technology may lead to a process of convergence, depending on the degree of economic development within an economy. Neoclassical growth theories predict convergence due to decreasing returns to reproducible factors. Finally, new growth theories maintain that economic growth may be influenced by factors such as market size, economies of scale and institutional structure, so differences in living standards would possibly persist.

The subsequent statistical analysis consists of two parts; a descriptive statistical section and an econometric inductive one. Two main goals are associated with this. Firstly, the stability of the convergence process across time and across countries is analyzed. Existing empirical analyses tend to suggest that the process has not been stable, and this chapter attempts to confirm this view. Secondly, there is an analysis of why differences in growth and convergence processes in the European Union over time and across countries persists.

Chapter Five provides the main conclusions of this study and derives implications for the European monetary integration process. In summary, the

empirical evidence suggests that structural differences across European countries exist and are likely to persist in the foreseeable future. Such structural differences may enhance political pressure, particularly in low-income, high-unemployment countries, to increase public spending which would contribute to higher public deficits and may involve a non-sustainable financial position within these countries. A non-sustainable financial position tends to be associated with negative external effects on other member states. The European Central Bank (ECB) may be forced to monetize the budget deficits, which would imply a higher inflation rate and an associated welfare loss for the other countries involved, or the defaulting government may ask for a net transfer from those governments which are solvent. These kinds of pressure on the ECB will be intensified in the presence of persistent differences in real economic activity.

To achieve a successful and stable monetary union in the presence of structural differences it appears particularly important to strengthen the institutional framework to make it less vulnerable to political pressure, and which will make policies in the union more credible, and to improve market transparency and information flows. Based on these arguments, the following policy proposals are formulated:

I. Broad interpretation of convergence criteria

An important issue in the transition to monetary union is how the convergence criteria determined in the Maastricht Treaty are to be applied. In principle, each country should be able to join monetary union as soon as it wants to do so. Each country may evaluate the costs and benefits of joining the union and decide if it is in its national interest to participate. However, the "necessary preconditions" as established in Art. 109j need to be taken into consideration.

II. Monetary policy coordination among the nonparticipants

The gradual transition approach will probably lead to a multi-speed monetary union. If this is the case, the possibility of splitting the European Union apart should be taken into account. As suggested in Chapter Three, a solution may be to create currency blocks in Europe. Those countries not eligible to enter the third stage initially might gain from forming a seperate monetary union (or unions). The efficiency gains obtained from these currency blocks would enable the lagging countries to catch-up those already in the third stage of monetary union.

III. Institutional strengthening

To strengthen the institutional framework of the EU the implementation of incentive contracts is proposed. Incentive contracts are arrangements by which the central banker is penalized for inflation. Several formulations of the incentive contracts for the executive board of the ECB may be thought of. Firstly, the in-

comes of the members of the executive board of the ECB might be made contingent on the state of the economy, thereby influencing the incentives the executive board faces in choosing the rate of inflation. Secondly, targeting rules might be enforced by making the ECB's budget depend on adherence to the rules. Thirdly, a stronger measure defining procedures for the removal of the executive board of the ECB should it fail to maintain price stability could be introduced. Whatever actual form the incentive contract took it would make the future ECB more accountable. At the same time, it would be costly for the governors of the ECB to succumb to national political pressures and would thereby contribute to securing price stability within the future union. The contract should include an inflation targeting procedure, similar to those already followed sucessfully by many central banks.

IV. Public debt management

A way to make policies more tenable is to enforce a time-consistent public debt management scheme. One way to do this is to require the use of short-maturity bonds in highly indebted countries. Short maturities reduce the government's incentive to produce surprise inflation and therefore would contribute to solving the time-consistency problems of fiscal policies in the EU.

An alternative, or complementary, way is to use inflation-indexed bonds - bonds whose interest payments and principal are tied to inflation. Index-linked bonds influence governments' incentives and so tend to make monetary policies more credible. In short, with nominal public debt, governments have an inducement to inflate debts away at the bond holders' expense. If payments of interest and principal increase with rising price levels, governments will be less tempted to implement inflationary policies. Index-linked bonds provide an additional benefit in that they can help governments to estimate financial markets' expectations of inflation. This is useful for monetary policymaking, as a rise in the expected inflation rate may be a sign that policy should be tightened directly. In this way the administration of monetary policies could be improved. Moreover, it would help in the prediction of long-term interest rates, as they contain inflation rate expectations and this would therefore contribute to the evaluation of risk more precisely.

Inflation-indexed bonds would both help markets to evaluate risk by providing estimates of inflationary expectations, and contribute to make monetary policies more credible by changing governments' incentives. In the future one might require the member states of the monetary union to issue inflation-indexed bonds. To obtain a self-balancing mechanism, highly indebted countries may be required

to issue a larger share of their outstanding government bonds in the form of inflation-indexed bonds than the low-debt countries.

2.The transition to European Monetary Union

2.1. Introduction

At the end of the 1980s new political initiatives to relaunch Economic and Monetary Union (EMU) among the member states of the European Union (EU) gained momentum. These initiatives culminated in the ratification of the Maastricht Treaty by the member states in the beginning of the 1990s. The Treaty formalizes three stages for moving towards monetary union. Before transition to the third, final stage, progress made in terms of economic convergence will be reassessed. Each country will be assessed individually before it is decided whether or not it can go forward to monetary union[1]. The Protocol referred to in Article 109f of the Treaty sets out four criteria for transition to the third stage relating to inflation performance, budget positions, exchange rate stability and long-term interest-rate convergence, which need to be fulfilled before entry into the third stage. Nominal convergence, i.e. convergence of prices, is, thus, considered a precondition for further moves towards economic and monetary integration.

Taking into account solely of nominal macroeconomic convergence may, however, be insufficient. If a similar evolution of real economic activity across member countries of the third stage is not achieved, there is a threat of pronounced regional differences in unemployment, incomes and growth. Pronounced international income disparities would imply the danger of social and political tension and, correspondingly, of macroeconomic instability. The congruent behavior of real economic activity will, thus, be an important factor for monetary union in Europe. Moreover, the Maastricht Treaty itself determines in its Article 2 economic and social cohesion, and thus real economic convergence, as a policy goal of the Community. Thus, while not a strict technical necessity, real economic convergence would be economically and politically helpful for the working of monetary union.

In this chapter, I contrast nominal convergence, as foreseen in the Maastricht Treaty, and real economic convergence. The formulation of the convergence criteria and the gradual approach towards monetary union has been discussed both in acadamic and political circles. I therefore critically review the transition process and provide a review of several reform proposals noted in the literature. The chapter thereby aims to lay out the economic policy background of the subsequent empirical analyses.

The chapter is structured as follows. Section 2 reviews the design of the transition process to monetary union as layed out in the Maastricht Treaty. In Section 3, the rationale of the Maastricht Treaty's convergence criteria is discussed. In Section 4 characteristics of participants in a monetary union suggested by economic theory are put in contrast to the existing barriers formulated in the Maastricht Treaty. The theory of optimum currency areas is used to show that convergence of real economic activity will be an important issue for monetary union. Section 5 discusses several reform proposals noted in the literature, while Section 6 summarizes and concludes the chapter.

2.2. The design of the transition process towards European Monetary Union

The Maastricht Treaty designs a gradual movement towards towards monetary union in three stages[23]. In the first stage, which began in July 1990, the member states of the European Monetary System (EMS) abolished all remaining capital controls[4]. The second stage started on 1 January 1994. A new institution, the European Monetary Institute (EMI), was created, which is supposed to strengthen monetary co-operation between national central banks. The third stage, the introduction of a single currency, will take place in the beginning of 1999, at the latest.

The European Council solidified the conditions for the transition process towards a single currency in Madrid in December 1995. The quality and timetable follows largely the proposal made by the EMI in November 1996. First, the choice of the participants of EMU will be made by the heads of state and/or government as early as possible in 1998. The decision will be based upon reports prepared by the EMI and the Commission and will rely on macroeconomic data for the year 1997. Second, as soon as the starting date for stage three has been determined, and no later than July 1998, the executive board of the European Central Bank (ECB) will be appointed by "common accord" of the EU governments participating in stage three, on the recommendation of the Council, and after consulting the European Parliament and the Governing council of the ECB[5]. The ECB will be established once the executive board has been appointed and will exercise its powers from the first day of stage three (Art.109l). The EMI will at the same time be liquidated, as the ECB takes over its functions.

The convergence criteria affect the decision making making process through their influence on the reports made by the EMI and the Commission. The Council has repeatedly emphasized that the convergence criteria will be applied

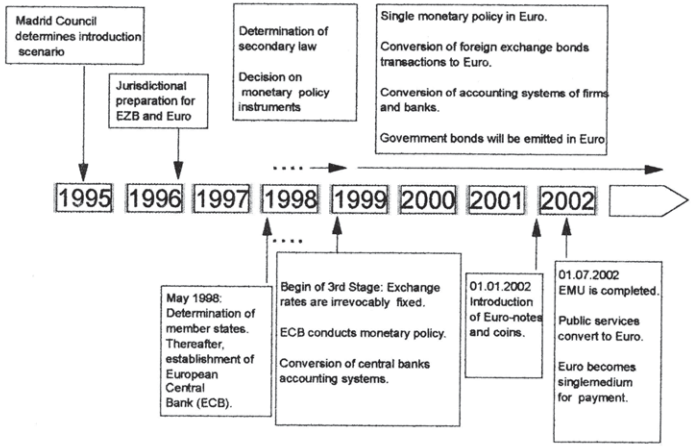
strictly. Article 109j of the Maastricht Treaty contains four convergence criteria, which are explained in a protocol to the treaty:

1. *Achieving a high degree of price stability*, which the protocol interprets as meaning that: ... an average rate of inflation, observed over a period of one year before the examination, that does not exceed by more than 1½ percentage points that of, at most, the three best performing Member States in terms of price stability. Inflation shall be measured by means of the consumer price index (CPI) on a comparable basis....

2. *Achieving a sustainable financial position*, which the protocol interprets as meaning that: ...at the time of the examination the Member State is not subject of a Council decision ... that an excessive deficit exists.

3. *Maintaining the country's exchange rate within the normal EMS band*, which the protocol interprets as meaning that: ... the Member State has respected the normal fluctuation margins ... without severe tensions for at least the last two years before the examination. In particular, the Member State shall not have devalued its currency's bilateral central rate against any other Member State's currency on its own initiative for the same period.

Fig. 2.1.: The timetable for the transition process to EMU.



Source: Based on Deutsche Bundesbank.

4. *Achieving a long-term interest rate indicative of durable convergence and of the country's participation in the EMS*, which the protocol interprets as meaning that: ...over a period of one year before the examination a Member State has an average nominal long-term interest rate that does not exceed by more than 2 percentage points that of, at most, the three best performing Member States in terms of price stability[6].

The decisions on entry into monetary union will take into account of the reports prepared by the Commission and the EMI, and the opinion of the European Parliament. The Commission and the EMI will base their recommendations on the fulfilling of the convergence criteria of Article 109j and on the fiscal "excessive deficits" criterion layed down in Article 104c for each individual country. It is important to note that the Council cannot stop the integration process. The Council has only to decide which countries are ready to enter the third stage and grant the authority of Art. 109k. All of the Council's decisions will be taken with qualified majority voting. No country will have the opportunity to exercise a veto. Thus, the Maastricht Treaty has created a transition-automatism to monetary union [see Kortz, 1996a,b][7]. There is a way to postpone monetary union, as noted by Kenen (1992) and Thygesen (1993a), by deciding before 1998 to start stage three after January 1, 1999. It is not possible, however, to abandon or to stop the monetary integration process[89].

It has been criticized that the formulation is rather slender and that there remains plenty of room for political interpretation [see, e.g., EMI, 1995; Hasse, 1995a; Schmidt and Straubhaar, 1995a,b]. Two examples may help to make the point: with respect to price stability, the formulation does not clarify whether the wording "at most, the three best performing member states" does not leave scope for judging price stability in relation to the performance of the two countries with the most stable prices or even to just the Member State with the best record in the past. There are also differences of opinion as to whether the 1½ percentage points are to be added to the average of the (one, two or three) reference countries or only to the inflation rate of the "worst" of them. Finally, the wording raises the question as to how "sustainable" price stability is to be assessed.

The criterion of exchange rate stability means that a member state must have "respected the normal fluctuation margins provided for by the Exchange Rate Mechanism of the European Monetary System without severe tensions for at least two years before the examination". After the widening of fluctuation margins from 2.2 per cent to 15 per cent on 2nd August 1993 as a result of "unprecedented exchange market pressures", the question arises as to which fluctuation margins are to be used as the reference point for measuring diver-

gence[10]. The application of the Maastricht Treaty's convergence criteria will thus remain subject to discretion and a matter of contemporary politics. The discretion does only refer to the decision on the eventual "ins" and "outs", and not to the decision of whether entering the third stage or not.

Table 2.1: Convergence criteria of the Maastricht Treaty (1997)

	Budget deficit (in % of GDP)	Public debt (in % of GDP)	Consumer Price Index (in %)	Long-term interest rate	Membership in EMS
Maastricht Criterion	-3.0	60.0	3.1	7.9	
Austria	-3.0	73	1.8	5.1	yes
Belgium	-2.9	127	1.9	6.2	yes
Denmark	-0.4	70	2.5	6.7	yes
Finland	-1.7	60	1.7	5.3	no[1)]
France	-3.2	57	1.3	6.4	yes
Germany	-3.4	63	1.5	6.1	yes
Greece	-5.7	105	7.2	.	no
Ireland	-1.1	76	2.0	6.9	yes
Italy	-3.7	123	2.5	7.7	no[1)]
Luxembourg	0.0	7	1.8	.	yes
Netherlands	-2.3	76	2.1	6.1	yes
Portugal	-2.9	68	2.6	.	yes
Spain	-3.7	69	2.9	7.7	yes
Sweden	-2.5	79	2.1	7.1	no
United Kingdom	-3.7	57	2.5	7.4	no

[1)]Finland and Italy joined the EMS in the end of 1996.

Source: OECD (1996).

In sum, economic convergence within the EMS member states is a precondition for further moves to economic and monetary integration. A long transition period is deemed as necessary to achieve convergence, since, it is argued, confidence in the permanence of EMU might be impaired if the economies of the participating countries would not converge sufficiently before their exchange rates were locked[11].

Presently, most forecasts conclude that the interest rate and the inflation rate criterion will be fulfilled by virtually all EU-member states (see Table 1). Only Greece is expected to exceed the inflation criterion. Five countries will not fulfill the exchange rate criterion, as it requires the participation in the EMS for two years in advance of the decision on participants in the union, thus since the

beginning of 1996. With respect to the budgetary criteria, member states have made large advances within recent years. The criteria will, however, most probably not be reached in 1997 by a large number of countries.

2.3. A critical assessment of the Maastricht Treaty's convergence criteria

The Treaty has established, as has been pointed out in the previous section, the need for a high degree of prior economic convergence as a precondition for the entry of each member state into EMU[12]. In this section, the economic rationale for the formulation of the convergence criteria is analyzed, focusing first on the monetary convergence criteria, i.e. those referring to exchange rates, interest rates and inflation rates and turning, thereafter, to the fiscal convergence criteria[13].

2.3.1. Monetary convergence

The monetary convergence criteria are economically closely related. Several economic explanations have been stated in the literature. Begg et.al. (1991) suggest that the exchange rate criterion is the most important one, because the success of the EU countries in avoiding realignments during the run-up to stage three would be an adequate test of their ability to bear the costs of reducing inflation in stage three itself. Langfeldt (1992) similarly stresses the need to reduce the risk of realignments during stage two so as to confer credibility on the locking of exchange rates at the outset of stage three and thus protect the monetary union from exchange rate crises before it has moved to using the ECU as its single currency. However, the potential of self-fulfilling expectations and speculative attacks being unrelated to economic fundamentals is ignored. Expectations of a devaluation can actually lead to a devaluation by leading to capital outflows that exhaust a country's foreign reserves[14]. In particular, expectations of a final realignment before the entry into the third stage will pose a threat to exchange rate stability which will be most probably independent from convergent macroeconomic fundamentals [De Grauwe, 1994b]. Moreover, if financial markets come to believe that a country will belong to the group of "outs", they may require a premium for higher inflation rates or future devaluations. In contrast, if markets expect that the country will enter the third stage, they might require a lower rate of return. Divergent interest rates are to be expected in either case. For payoffs of investors to remain equalized, the exchange rate needs to move. Central banks have to intervene in order to keep the

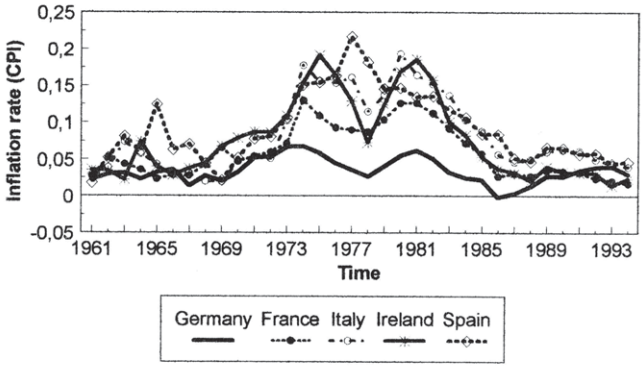
exchange rate unchanged, thereby foreign reserves will be exhausted and speculative attacks will occur.

Lesch (1993) refers to monetary theories of exchange rates as economic foundation for the exchange rate and inflation rate criteria. Monetary exchange rate theories maintain that the nominal exchange rate is determined in the long-run by price differences across countries[15]. A country with a relatively greater loss of purchasing power is subject to devaluation pressure; a country with a relatively smaller loss of purchasing power in contrast is subject to revaluation pressure. Central here is the purchasing power parity (PPP) relation, according to which, in the long-run, domestic and foreign price levels are related by the nominal exchange rate.

$$p_t = p_t^* \cdot e_t \qquad (2.1)$$

where p_t and p_t^* denote the domestic and foreign price levels, respectively, and e_t refers to the nominal exchange rate. By differencing equation (1) we obtain the relative PPP condition

Figure 2.2.:
Inflation rate performance in selected EU countries



Source: OECD Main Economic Indicators, Paris.

(2.2) $\Delta e_t = \Delta p_t - \Delta p_t^*$

From equation (2), exchange rate movements are determined by inflation rate differentials. It follows essentially from these kind of models that convergent inflation rates are necessary for stable exchange rates in the long-run. At the same time, inflation cannot be influenced by the exchange rate. One extreme view that results from this argumentation, the so-called "coronation theory"[16], is that it would be necessary to wait for a full convergence of inflation before it is advisable to go to monetary union by irrevocably fixing exchange rates [Gros and Thygesen, 1992 pp. 473][17].

Empirically, differences of inflation rates between EU economies have been reduced during the 1980's, as can be seen from Figure 2. France, Denmark, Ireland, in particular, but also Italy and Spain have reduced their inflation rates. The figure seems to suggest, however, that inflation rate convergence is associated with the existence of a fixed exchange rate system. Inflation rates during the 1960's have been low and similar within the Bretton-Woods exchange rate system. After the collapse of the Bretton-Woods system in 1973, levels of inflation rates have been rising in the 1970's until the EMS was introduced in 1979. If such a a systematic relation indeed was to hold, as has been argued by Giovannini (1989), inflation rate divergence after the collapse of the EMS is to be expected.

Let's turn to the economic foundation of the interest rate criterion. Issing (1992) interpretes the long-term interest rate criterion as an additional, reassuring indicator for convergence of price stability and budgetary discipline[18]. This argument is problematic, however, as has been pointed out by Lesch (1993), because it is unclear which inflation rate is expected by market participants. The average long-term interest rate incorporates the expected inflation rate. In the year before the adoption of a common currency the expected inflation rate will not depend on national monetary policies, but rather will be associated with the expected monetary policies of the future ECB. The actual inflation rate, in contrast, is more reflected in the short-term interest rate level. In other words, the long-term interest rate mirrors the credibility of the future ECB while the short-term interest rate reflects the credibility of the current national central bank. Economies with more than average inflation rates gain from imported credibility, which is however only the result of the supranationalisation of their monetary policies. The imported credibility reduces the level of long-term interest rates. Long-term interest rates may, according to this line of argumentation, converge more than justified by economic fundamentals. Convergence depends then

mainly on how market participants evaluate the probability of the economy to enter into the third stage.

The sources of differences between nominal interest rates at home and abroad can, in order to obtain a more systematic view on the international relation of interest rates, be summarized by the following equation:

$$(2.3) \qquad i_t = i_t^* + E_t(\Delta e_{t+k}) + Risk_t + Dom_t + Bar_t$$

where i and i* are, respectively, nominal interest rates in home and foreign currency denominated assets of a given maturity; $E_t(\Delta e_{t+k})$ reflects future expected exchang rate changes; $Risk_t$ constitutes the part of the differential due to the uncertainty in returns from investing in a foreign asset and to the risk of changes in the exchange rate over the period of the investment; Dom_t is the portion of the differential that is due to differences in the characteristics of the assets besides maturity, such as liquidity or tax treatment. Bar_t represents the part of the differential that is due to government policies and institutional imperfections (capital controls) that effectively impede financial flows across national jurisdictions. Dom_t and Bar_t are country-specific risks reflecting factors that may lead to imperfect substitutability between bonds denominated in different currencies.

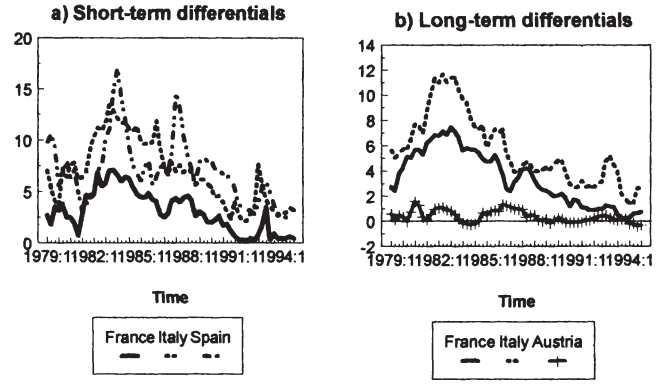
If $Risk_t$, Dom_t and Bar_t are zero, or, in other words, if bonds that differ only in their currencies of denomination are perfect substitutes, equation (3) represents the classic uncovered interest parity condition. Uncovered interest parity states that the nominal interest differential between similar bonds denominated in different currencies must equal the expected change of the exchange rate over the holding period [e.g. Cumby and Obstfeld, 1984]. Equation (3) also shows that even when exchange rates are credibly fixed, so that $E_t(\Delta e_{t+k})=0$, interest rates can still differ across countries, due to country-specific risks like tax differences or default risk. It follows that nominal interest rate differentials may be of no greater use as precondition for monetary union. Observable long-term interest rate differentials reflect a number of different expectations, from default risk to debt maturity differences, which are not necessarily related to monetary integration.

In Figures 3 a) and b) short-term and long-term interest rate differentials of selected EU economies relative to Germany for the period 1979 to 1994 are displayed. The interest rate criterion of the Maastricht Treaty requires convergence only of long-term nominal interest rates. A positive value indicates a higher interest rate in the foreign country than in Germany. Most countries' interest

rates, both short-term and long-term, have been higher than the ones in Germany. Differentials of both rates have been reduced in recent years. While during the EMS crises, differentials, in particular, of short-term interest rates have increased, they have been reduced thereafter again. Long-term interest rates have converged in recent years, largely because of the elimination of capital controls in Europe in relation to the entry into the first stage of monetary union.

It is noteworthy that interest rates in Germany have been almost consistently below other economies' interest rates in Europe. This reflects the high reputation and credibility of the Deutsche Bundesbank, which is based on a long tradition of a relatively stringent and conservative monetary policy and on its political and economic independence[19]. One motivation for the other countries to participate in the EMS, that has been mentioned frequently in the literature, is to import the credibility of the Bundesbank and to use a system of fixed exchange rates as an institutional constraint for their own monetary authorities.

Figure 2.3. :
Interest rate differentials relative to Germany



Source: OECD Main Economic Indicators, Paris.

The general idea of this argument is that authorities that have the discretion to alter the nominal exchange rate, will tend to abuse their power, introducing an

inflationary bias into the economy [e.g. Edwards, 1992]. Under plausible conditions, such as the existence of labor market rigidities that preclude the economy from reaching full employment, it will be optimal for the authorities to surprise the private sector through unexpected devaluations.By engineering these unexpected devaluations the government expects to induce a reduction in real wages and, thus, an increase in employment and a boost in output. In equilibrium, with rational private agents who take this information into account in forming their inflation expectations, the public will anticipate the devaluation surprises and hence render them ineffective. As a consequence, the inflation rates will be relatively high in the long-run, without a positive effect on employment. A key policy implication of this literature is that a way to gain credibility is by "tying the hands" of the authorities[20]. A fixed exchange rate system may serve as such an institutional constraint that limits the scope for activist policies of monetary authorities. The adoption of a fixed exchange rate constrains governments ability to surprise the private sector through unexpected devaluations. Promises of monetary discipline become credible and private sector decisions do not elicit successive rounds of inflationary actions. Countries with a history of relatively high inflation, and correspondingly relatively low monetary reputation, thus entered the EMS in order to limit the scope for unexpected devaluations of their own monetary authorities.

A similar line of reasoning has been applied to analyze the economic rationale for the convergence criteria [De Grauwe, 1994a]. When the member states of the European Union, which are characterized by different reputations concerning inflation, decide to form a fixed exchange rate system, like EMU, the high-inflation countries import the credibility of the low-inflation countries and thereby most likely benefit from the reputation of the low-inflation countries. The low-inflation countries do not benefit from participation in the union and may, in contrast, be infected by the bad reputation of the high inflation countries. Thereby, the low-inflation countries may experience a welfare loss. Since the low-inflation countries may loose when they join the union, they seek to impose conditions for the participants of the union in order to avoid the welfare loss. Thus, the convergence criteria of the Maastricht Treaty are formulated, due to the interests of the low-inflation countries, in order to provide evidence that the high-inflation countries care about a low inflation rate in the same way as the low-inflation countries do and, in particular, as Germany does. This they do by bringing the inflation down to a common level. During this disinflationary process, a temporary increase in unemployment, due to a movement along the short-term Phillips curve, will be inevitable. This self-imposed suffering is added

evidence for the low-inflation countries that economies like Italy are serious about fighting inflation. Once the proof is given, these economies can be left into monetary union. To use the Maastricht Treaty as such an institutional constraint on the political authorities and the fulfilling of the convergence criteria as evidence for future preferences of the authorities in high inflation countries would, however, if this was a motivation for the formulation of the convergence criteria, have been a misleading approach. The reason is that nothing in the formulation of the criteria can rule out strategic behavior of future member states [De Grauwe, 1995]. Countries may act opportunistically, i.e. they may pursue disinflationary policies today so as to gain access later. Once they are in the union, they may reveal their true preferences. The executive board of the ECB will be chosen by "common accord" of the EU governments participating in stage three. Thus, the board of governors may, as representatives of the participating countries, be subject to political influence[21]. They will be able to influence monetary policy and to put the "hard-nosed" representatives in a minority position. In addition, even if the present governments of the candidate member countries are serious about inflation and submit themselves to the disinflationary process, they do not commit future national representatives in the ECB to the same monetary policy stance. Governments change, and so do preferences with respect to inflation. The fact that, for example, Italy has reduced its inflation rate in recent years so as to be accepted in the monetary union, will not bind the Italian representative in the ECB in the future to follow the same low inflation policies. At that time the policies of the present Italian representatives will have become irrelevant. The only relevant constraint after the entry into the third stage will be the fact that the ECB is politically independent and that its statutes commit the ECB to a stable monetary policy.

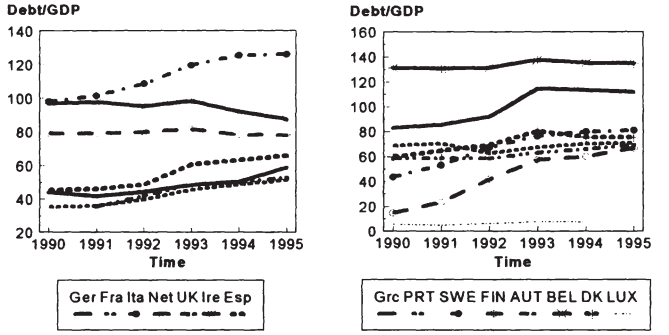
2.3.2 Fiscal convergence

The monetary convergence criteria are supplemented in the Maastricht Treaty by restrictions on public debt and public deficits. According to the Treaty, member states shall regard their economic policies as a matter of common concern (Article 103) and must coordinate them to achieve the community's objectives. Governments cannot, however, be penalized for failing to coordinate their policies. In contrast, if a non-sustainable financial position in the sense of Article 109j is found by the Commission, a complicated procedure is set in motion which may lead to serious consequences for the member states. Article 104c determines this procedure in response to excessive deficits. If a member state is

in a non-sustainable financial position, which is given when it exceeds the reference values provided in the Protocol on the excessive deficits procedure - 60% of its GDP for the government debt and 3% of its GDP for the public deficit - the Commission prepares a report for the Council. The Council decides on the matter and may make corresponding recommendations to the member state which are aimed to bring the situation to an end "within a given period". If the member state does not respond appropriately to the recommendations of the Council, they may be made public. Eventually, if the member state still fails to put an end to the situation, the Council may apply one or more of four measures: (i) The member state may be required to publish additional information before issuing bonds and securities. (ii) The European Investment Bank may be advised by the Council to reconsider its lending policy towards this member state. (iii) The member state may be required to make a non-interest- bearing deposit until the excessive deficit has been corrected. (iv) The Council may impose "fines of an appropriate size" on the member state. It follows that, "in the long-run", the violation of the excessive deficit criterion may lead to quite drastic consequences for the economies. If a country fails to avoid an excessive deficit, due to Article 109j, it will also not be allowed to enter into the third stage. In contrast to the monetary convergence criteria stated in Article 109j, which will be redundant, the fiscal criteria will be of importance even after entry into the third stage. While the fact that they are binding for member states, even after the adoption of a common currency is, in principle, an advantage, there remain several problems associated with the fiscal criteria[22]. Indeed, the fiscal criteria have been subject to substantial critique by economists [see Giovannini and Spaventa, 1991; Buiter,1992; Goodhart, 1992; Hasse, 1992; Buiter et.al.,1993; De Grauwe, 1994].

A look at the public debt rates of the present EU member states shows that most countries will have great difficulties to fulfill the criterion. In 1990, at the time of the beginning of stage one of monetary union, six countries had debt ratios that exceeded the reference value. By 1993 this number had risen to 10 countries and in 1995 only four countries (France, Germany, Luxembourg, United Kingdom) were below the public debt reference value. Thus, the public debt situation has deteriorated in recent years. Indeed, for some countries the fiscal criteria are out of reach for the foreseeable future.

Figure 2.4.: Public debt ratios of EU countries



Source: OECD Economic Outlook, 1996.

Take the relation between government deficits and government debt.

(2.4) $$\Delta b_t = g_t - t_t + (i - x - \pi)b_{t-1}$$

where b_t is the debt to GDP ratio and Δb_t is the change in public debt relative to GDP, thus the public deficit (relative to GDP). g_t is the primary government spending as a percentage of GDP; t is the tax rate; i is the nominal interest rate; x is the rate of growth of real GDP and π is the rate of inflation. $(g_t - t_t)$ is then the primary deficit rate in the economy. If we combine the primary deficit rate with the interest payments on previously accumulated debt, we may rewrite equation (4) as in

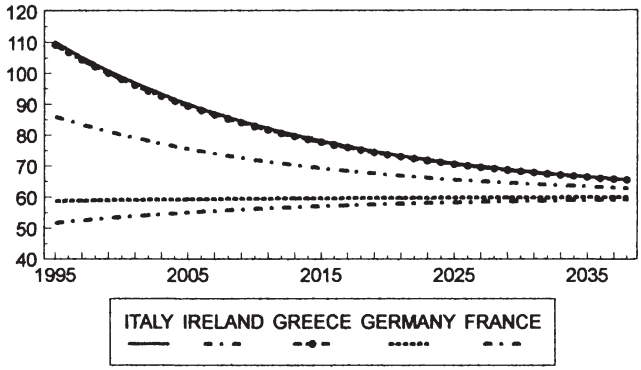
(2.5) $$\Delta b_t = def_t - (x + \pi)b_{t-1}$$

where $def_t = g_t - t_t + ib_{t-1}$. Equations (4) and (5) give a dynamic relation between public debts and public deficits. To stabilize the government debt at 60% of GDP, the budget deficit must be brought to 3% of GDP if and only if the growth rate of nominal GDP is 5% [Buiter, 1992][23]. Based on these values, Figure 2.5 displays the simulated adjustment process for EU economies.

It will take long for the highly indebted countries to fulfill the fiscal criteria. For those countries with a current public debt that exceeds 100% of GDP, for ex-

ample, it will take more than 40 years to reach the reference value, provided that the annual deficit does remain at 3% of GDP[24]. It is ex post somewhat surprising that such harsh fiscal criteria were accepted by the member states' governments. It may partly be explained by the fact that initially, in the end of the 1980's, the fiscal situation in most of the European countries was far better than now.

Figure 2.5.:
Public debt adjustment process in selected EU countries



Source: Own calculations.

Apart from the unrealistic determination of the fiscal criteria, an immediately obvious point for critique in the formulation of the convergence criteria refers to the arbitrary numerology [e.g. Buiter, 1992]. These numbers are not on reason, they could just as well have been values like 10 or 46[25]. The arbitrary nature of the criteria is, however, to a large degree inherent in the methodology of imposing any numerically specified barriers of entry in advance of monetary union[26].

The problem of creative accounting, that is, for example, the invention of new fiscal programmes so that necessary expenditures can be placed "off budget" and therefore "put off ratio", is not tackled [Hughes Hallett and Scott, 1992]. Indeed, by using the nominal gross debt of the general government, in contrast to

the net non-monetary liabilities of the consolidated general government and central bank, the criteria encourage creative accounting [Buiter et.al., 1993]. It is thus likely to be a relevant issue in the transition process. The public debt in Germany, for example, amounted to 50,2% of GDP in 1994 and jumped to 58,6% in 1995. The reason for this extraordinarily strong increase in the amount of public debt is not, or only to a minor extent, deficit spending by the German government in this year, but rather the belated change in the fiscal accounting system related to German unification. Bovenberg et.al. (1991) emphasize that different financing of government pension obligations to its employees affect its long-run financial position. In the Netherlands, for example, supplementary civil service pensions are essentially funded, while in Germany and France public-sector pensions are essentially unfunded. While these differences may be taken into account of statistically, they induce potential for accounting transfers. Moreover, the criteria do not make any allowances for cyclical factors or for growth of foreign assets[27]. Growth rates of real GDP, for example, will continue to differ across countries in Europe. Convergence of living standards requires that poor countries grow faster than rich ones. Countries with a higher growth rate can indeed support a higher deficit-GDP ratio without solvency problems (see equation 2.5).

These points of critique refer largely to the particular formulation of the criteria. They could have been taken into account by policymakers relatively easily. In addition, however, there are several fundamental issues associated with imposing fiscal restrictions in advance of an introduction of a single currency, to which I turn next. The emphasis thus turns more to the economic rationale of fiscal restrictions in advance of monetary union per se. Two reasons have been noted for imposing fiscal restrictions in advance of EMU. One refers to an international externality associated with a country's public deficit, the other applies to the consequences of non-sustainable fiscal policies for the member states in a monetary union.

Fiscal policies within one country may exhibit negative externalities for the other economies [e.g. Bovenberg et.al., 1991]. The mechanisms involved may be described as follows. An expansionary fiscal policy in the domestic country, which is, with unchanged government revenues, associated with higher budget deficits, has two effects. On the one hand, in the short-run, it leads to an increase in aggregate demand and to higher output growth in the country. On the other hand, it implies a higher demand for capital and, with the supply of capital fixed, a higher rate of return on capital. A higher interest rate depresses investment demand and affects aggregate demand negatively. The higher public deficit will

force the government to raise taxes in the future, both to service the new debt created by the budget deficit and to cover the increase in interest payments on the existing stock of debt. This increase in taxes will reduce the future capital stock and future output growth, as far as taxes are distortionary. An increased interest rate in the domestic country will, with integrated capital markets, additionally affect the interest rate in foreign countries. Thereby foreign countries will have to bear part of the costs associated with the public deficit in the domestic country. In other words, there is a negative effect for the foreign countries in relation with a higher public deficit in the domestic country.

How likely to be relevant are these kind of externalities? De Grauwe (1989, 1994a) argues that they will be of relatively little importance. He points out that an increased demand for capital will in general be satisfied by the international supply of capital and will possibly not lead to a rise in interest rates at all. This view is based on the fact that world capital markets are becoming increasingly integrated and efficient, so that interest rates are becoming more and more equalized everywhere and no single country maintains the ability to affect them. Kenen (1995), however, argues that this argument applies only to small economies and that public debt in relatively large economies like Germany or Italy would probably affect the union's interest rate. The second argument for an international surveillance of national fiscal policies is associated with the solvency problem of sovereign debtors. A debtor is said to be solvent if his obligations are not larger than the present value of the revenue stream available to service them. This implies the solvency condition that the growth in nominal GDP, which determines the extra revenue stream available for servicing, must be at least as great as interest payments (see equation 2.5). A solvency problem of a member state of the EU, and in particular a default of a member state, it is argued, may involve international spillover effects. In general, if a government fiscal programme is not solvent, its options are either to raise taxes / cut expenditures to remain within the limits, to finance the deficits by money creation, or by transferring the responsibility for the debt to other governments or the central bank. The government may then be obliged to turn increasingly to the union's capital markets, driving the interest rate upward [Hughes Hallett and Scott, 1992]. In addition, it is feared that the new ECB may be forced to monetize the budget deficits, which would imply a higher inflation rate and an associated welfare loss for the other countries, or that the defaulting government may ask for a net transfer from the solvent governments. Moreover, a national debt default may have adverse systemic effects on the EU-wide financial system

or its key components, the banking system and the payments system. A financial panic and liquidity crisis could be the result [Buiter et.al., 1993][28].

The Maastricht Treaty intends to deal with the potential consequences of national default by including a "no bail-out" principle. Article 104b states that: "The Community shall not be liable for or assume the commitments of central governments, regional, local or other authorities, other bodies governed by law, or public undertakings of any Member State, without prejudice to mutual financial guarantees for the joint execution of a specific project. A Member State shall not be liable for or assume the commitments of central governments, regional, local or other authorities, other bodies governed by public law or public undertakings of another Member State, without prejudice to mutual financial guarantees for the joint execution of a specific project". That is, if a member government fails to service its debt, the defaulting country will bear the consequences of such a fiscal crisis itself. The Treaty thus attempts to prevent the negative consequences of one country's default through a binding precommitment of the member states to carry the sole responsibility for the own debt themselves.

The effectiveness of the no bail-out clause depends on whether it needs to be enforced, and whether it can be enforced. The need for enforcement of the rule is contested [see e.g. Scheide and Trapp, 1991]. If the Italian authorities, for example, were to continue issuing large amounts of debt, they would have to pay a growing sovereign risk premium on the Italian interest rate. Eventually, the Italian authorities would be unable to sell debt in any currency at any rate of interest. The risk premium is country-specific and is paid solely by the Italian government without affecting other countries. Thus, with markets pricing risk accurately, the default of a member state would not involve negative international spillover effects. While the ability of markets to evaluate risk accurately is contested, financial innovations and financial integration may contribute to increasingly accurate risk evaluations in the future[29]. The ability to enforce the no bail-out clause may be restricted by political pressure. The defaulting government may ask the ECB to acquire debt or solely to adjust its monetary policy to the need for low interest rates. While the enforcement of the no bail-out clause depends ultimately on the political will to do it, the Treaty has made clear that to achieve a sustainable financial position is within the responsibility of national governments and of their own citizens. In addition, the political pressure to organize a bail out is not necessarily higher when indebted countries default while they are members of the union than while they are not. When, for example, Italy is not allowed in the union, one can expect that a default will also put a lot of pressure on the other EU members to bail out the Italian government [De

Grauwe, 1996]. The effectiveness of the no-bail out clause is thus likely to be relatively low.

De Grauwe (1996) reformulates the time inconsistency problem of low-inflation policies in EMU due to government debt[30]. The problem stems from the fact that an unanticipated component of inflation affects the nominal budget constraint, i.e. inflation that is higher than expected lowers the nominal debt burden. Fully anticipated inflation, in contrast, does not lower the debt burden. It follows that there is a trade-off between the tax rate and the inflation rate, i.e. an unexpected increase in inflation allows the government to reduce taxes while keeping the solvency constraint intact. This trade-off, however, holds only if inflation is unanticipated. In equilibrium, with rational private agents who take this information into account in forming their inflation expectations, the public will anticipate the inflation surprises and hence render them ineffective. As a consequence, the inflation rates will be relatively high in the long-run, without a positive effect on the debt burden. He emphasizes that the convergence requirements may lead to higher than necessary economic adjustment costs. The reason is that if a disinflationary strategy is not fully credible, an observed decline in inflation is not matched by a decline in the expected inflation. The debt burden is thereby increased. The authorities must therefore increase taxes just to prevent the debt to GDP ratio from increasing. Thus, the convergence requirement makes debt reduction more difficult when, as in the case of Italy, a credible anti-inflationary policy is difficult to follow. He concludes that the Maastricht convergence requirements increase the costs of the debt reduction.

While there are pros and cons, the economic case for the convergence criteria seems rather weak. The main arguments against the monetary convergence criteria may be summarized as follows. Exchange rate volatility is not the right indicator for economic convergence, since exchange rate movements may not be associated with macroeconomic fundamentals. In advance of monetary union financial volatility is to be expected, which may imply speculative attacks due to self-fulfilling expectations. The long-term interest rate criterion does not necessarily provide accurate information on convergence, since observable interest rates incorporate all sorts of expectations. Interest rates may be distorted by markets' expectations on the governments' own actions. With respect to inflation rates, the important determinant of price stability is the independence of the European Central Bank. The inflation rate criterion does not provide any additional guarantee with respect to price stability in the union. If the case for the monetary convergence criteria is weak, the economic rationale for the fiscal criteria is even weaker. Countries have to follow sustainable fiscal policies

irrespective of the monetary regime [Buiter and Kletzer, 1991]. There is indeed a general conviction among economists that ex ante limitations on debts and deficits are not an appropriate way to secure the sustainability of a financial system[31]. It seems most relevant to strengthen the applicability of the criteria after the adoption of a common currency.

We may conclude, on the one hand, that macroeconomic stability in the future monetary union may be achieved although the criteria are not fulfilled. Public deficits, for example, in excess of the Maastricht Treaty's reference value would not put a threat on the solvency condition of the government and, correspondingly, on the stability of the union, as long as the rate of economic growth in the country is sufficiently high.

On the other hand, the fulfillment of the criteria does not guarantee macroeconomic stability in the future monetary union. If the ECB decides to pursue an inflationary monetary policy, price stability would be endangered although all criteria might have been fulfilled in advance. In other words, the fulfilling of the convergence criteria is neither necessary nor sufficient for macroeconomic stability in the future monetary union in Europe[32].

At the meeting of the European Council in Dublin in December 1996, the heads of state have agreed on a stability pact, which is supposed to provide additional security with respect to macroeconomic stability within the union. The compromise reached between Germany and France does not incorparate fully automatic sanctions in response to excessive deficits, as it was proposed by the German government. The stability pact does, however, complement the rules determined in the Maastricht Treaty by providing additional safeguards that aim to secure macroeconomic stability in the union. In case of failure of a member country to satisfy the stability criteria, sanctions in form of fines and non-interest-bearing payments are defined. However, the formulation of the stability pact does leave room for interpretation, which renders budgetary policies within the union open to political discretion, as has been criticized by Siebert (1997) and Vaubel (1997).

2.4. Convergence criteria and economic theory

In this section, the nominal convergence criteria of the Maastricht Treaty are contrasted with convergence criteria suggested by economic theory[33]. While we have seen in the previous section that the economic rationale of the convergence criteria is weak, in this section it is analyzed whether they address the economically most relevant variables. I refer to the theory of optimum currency

areas (OCA) to derive "economic reference criteria", which can be compared to the criteria determined in the Maastricht Treaty. A currency area between two or more countries means that those countries agree to irrevocably fix their exchange rates. Thus, the central point about a currency area is that, when countries proceed to join one, they give up the possibility of allowing the exchange rate between their own currency and those of the other members of the union to vary. The formation of a currency union implies benefits and costs for the participating countries[34]. The benefits stem mainly from having a single currency to use over a wider area. The underlying idea is that money, in general, facilitates transactions and thereby increases economic efficiency to a situation of barter. The social benefit derived from money is, moreover, enhanced by stability in its value, that is, by price stability. The widest possible use of a single money that exhibits such stability would minimize transaction costs and maximize its international role. The major cost involved in participating in a currency area, or forming a monetary union, is foregoing the use of the nominal exchange rate as a tool for macroeconomic adjustment. In other words, when participating in a currency area, a country relinquishes an instrument of economic policy and loses its ability to conduct a national monetary policy. The size of this cost will depend on several factors; factors that have been suggested by the OCA theory. The theory of optimum currency areas has been developed originally in the 1960's and 1970's and compares the economic costs of a fixed exchange rate regime with the economic costs of a flexible exchange rate regime. By doing so, it obtains certain characteristics, or preconditions, of participants in a monetary union, which will be listed with a brief explanation of their rationale below[35] .

(i) Factor mobility

Countries with a high degree of factor mobility are considered suitable candidates for monetary integration, since factor mobility is a substitute for exchange rate flexibility in international adjustment to shocks. If wages and prices are sticky, real exchange rate depreciation can only be accomplished through nominal exchange rate changes. However, depreciation would be ruled out if the two regions were part of a monetary union. Therefore, Mundell (1961) argued that unless factors of production can freely move between regions, shifts in demand facing a region relative to another may lead to unemployment in the absence of flexible exchange rates.

(ii) Wage and price flexibility

When shocks have asymmetric effects across countries, a movement of the real exchange rate is required to restore macroeconomic equilibrium. If wages and prices were to adjust instantaneously, they would induce a prompt re-equili-

brating response of the real exchange rate and there would be no loss from relinquishing the nominal exchange rate. Thus, when prices and wages are flexible between regions, the transition towards adjustment between regions is less likely to be associated with unemployment in one region and inflation in another, diminishing the need for exchange-rate adjustment and the introduction of a single currency is facilitated. Masson and Taylor (1993) point out that it is important to distinguish between two types of wage and price flexibility: real and nominal. Changes in a nominal price like the nominal exchange rate are a substitute for domestic price or wage changes, and may facilitate real adjustment. In the limiting case of perfect real wage rigidity, for instance, due to complete indexation of wages, employment and net exports would be unaffected by nominal exchange rate changes. In the other limiting case of perfect flexbility of real wages, the freedom to modify the nominal exchange rate can be helpful in the case of nominal wages being sticky but redundant in the case of nominal wages or prices themselves being flexible enough to do the job of altering real exchange rates. In other words, the usefulness of changes of the nominal exchange rate in response to asymmetric shocks depends on the nature of the rigidity. While the nominal exchange rate may be used in a case of a nominal rigidity, it is of no help in the case of a real wage rigidity.

(iii) Fiscal integration

Budgetary transfer payments between two countries help reduce the negative effects of shocks on real economic activity. When a country joins a monetary union, fiscal policies become an important stabilization instrument for member governments to react in response to asymmetric shocks. Indeed, with monetary policy not being feasible in a fixed exchange rate system, fiscal adjustments remain the sole macroeconomic policy instrument. Fiscal adjustments need not involve discretionary policy, but rather can be the result of the operation of automatic stabilizers. A possible complement is a system of fiscal taxes and transfers between members of a currency union, thus a form of fiscal federalism. Currency areas are therefore optimum if there is also a willingness to undergo fiscal integration and hence to centralize a significant part of the national budgets to the European level[36]. In addition, if such a centralization of the national government budgets in a monetary union is not possible, national fiscal policies should be used in a flexible way. The fiscal convergence criteria of the Maastricht Treaty do, however, reduce the fiscal flexibility for member governments and thereby put an additional limitation on member states macroeconomic policies.

(iv) Openness of the economy

Open economies tend to be suited for systems of fixed exchange rates, as exchange rate movements have relatively weaker effects on real competitiveness. In order to maintain external balance in the face of an asymmetric shock, resources in a fully employed economy must be shifted toward production of traded goods and away from non-traded goods sectors. The smaller the non-traded goods sector, the larger the exchange rate change needed to transfer a given amount of resources, and the larger the movement in internal prices that would result. Open economies thus tend to prefer fixed exchange rate arrangements as exchange-rate changes in such economies are not likely to be accompanied with significant effects on real competitiveness. This criterion also implies that smaller countries are better suited for monetary union than large countries.

(v) The degree of commodity diversification

If a country produces a wide variety of goods, and shocks occurring either to the supply side or as shifts in relative preferences, then the effect of any shock on output will be less than the effect on individual sectors. Diversified economies are thus regarded as better candidates for monetary union, since a high level of diversification offers protection against the effect of shocks specific to particular sectors.

(vi) Similarity of inflation rates

If inflation rates are similar, a smooth flow of current account transactions can be expected. Consequently, monetary unions are optimum if the inflation rates in member states are similar.

(vii) The degree of goods market integration

Terms-of-trade shocks have a symmetric impact in countries with similar production structures, so that the exchange rate is redundant as an adjustment instrument. Accordingly, countries with similar production structures are better candidates for monetary union.

(viii) Volatility of real exchange rates

As the aforementioned characteristics are difficult to quantify, it has been suggested that the volatility of real exchange rates should be used as an all-embracing criterion for admission to a monetary union. The smaller real exchange rate fluctuations have been in the past, the better suited a country is for membership of a monetary union.

(ix) Political factors

Finally, the political desire for monetary integration is emphasized as a deciding factor for the success of monetary union.

To summarize, exchange rates can be fixed, and a monetary union is optimal, according to the theory of optimum currency areas, if the structure of the economies is "similar" and if goods and labor markets react flexibly to real economic changes[37]. If these theoretical characteristics of an optimum currency area are compared with the nominal convergence criteria laid down in the Maastricht Treaty, a striking discrepancy between economic theory and political reality is to be noticed. The Maastricht convergence criteria are nominal criteria, whereas the characteristics suggested by economic theory relate to real economic activity[38]. It has therefore been argued that real economic convergence is an important prerequisite for EMU [see e.g. Heylen et.al 1995; Schmidt and Straubhaar, 1995][39]. If real economic convergence does not occur, the argument goes, and if economic and monetary union prevents individual regions from taking specific economic measures in order to respond effectively to shocks, there is a danger of pronounced regional differences in unemployment, incomes and growth. In addition, Heylen and Van Poeck (1995) emphasize that an EMU encompassing partners with unequal real performance may experience much conflict about the stance of monetary policy of the union's central bank. All other things being equal, member states with a high unemployment rate will argue for a more expansionary policy than countries with a low unemployment rate, which will lead to differences in opinion as to the correct way to conduct monetary policies. Goodhart (1995) argues that politicians may blame depression on EMU and will start to advocate the retreat from monetary union, which will endanger the political and economic stability in the EU. Moreover, the Maastricht Treaty itself determines real economic convergence as a policy goal of the Community. In its Article 2, the Treaty includes economic and social cohesion as a fundamental principle the Community seeks to respect. Article 130a states that: In order to promote its overall harmonious development, the Community shall develop and pursue its actions leading to the strengthening of its economic and social cohesion. In particular, the Community shall aim at reducing disparities between the levels of development of the various regions and the backwardness of the least-favoured regions, including rural areas. It follows that real economic convergence in the European Union is desirable both for economic and juridical reasons. While not a technical necessity, real economic convergence is helpful for the working of the monetary union.

2.5. Reconsidering the transition process

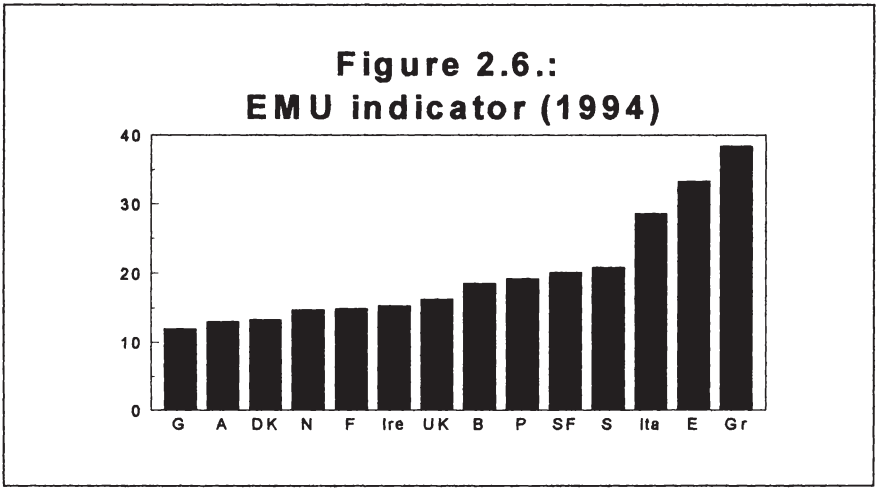
The Maastricht Treaty has determined a transition-automatism that will lead to monetary union of at least two countries by the end of the decade. If the Maastricht convergence criteria are, however, largely inconsistent, as has been argued in the previous sections, and, furthermore, are unlikely to help in advancing EMU for all but a few member states, it remains to think about better ways to achieve EMU. The proposals made by economists range from imposing additional hurdles in advance of European monetary union in order to make the existing entry barriers more effective to a de facto abandonment of the Maastricht Treaty convergence criteria. In this section, some of the main reform proposals are presented[40].

Several suggestions for reform have argued in favor of alternative, and additional, convergence criteria. It is maintained that, because the present convergence criteria do not guarantee macroeconomic stability, additional indicators need to be used. De Grauwe and Gros (1991) and Gros and Thygesen (1992) propose the adoption of an overall "EMU indicator", which takes into account of a broader macroeconomic framework. They argue that the inclusion of supplementary economic indicators in the Commission and EMI reports, based on Art. 109j, is evidence that there will also be efforts to see the main convergence criteria in a broader macroeconomic framework. The value of the indicator is given by the sum of five variables: *inflation* (CPI), *public sector deficit* in per cent of GDP, the *public debt surplus* (in per cent of GDP) needed to bring the national debt to GDP ratio to the reference value of the Treaty within ten years, the *unemployment rate*, and the external *current account balance* in per cent of GDP[41]. The proposed indicator differs from the formal convergence criteria of the Treaty in three aspects: first, it uses an absolute standard in all respects rather than relative inflation measures, second, by aggregating the various indicators extra creditable performance in one respect is allowed to compensate for deficient performance in other respects and, third, it incorporates explicitly convergence of real economic activity.

Table 2.2. and Figure 2.6. display the composition of the EMU indicator for 1994. The figure shows that there is a group of about seven countries with quite "good" macroeconomic performance, consisting of Germany, Austria, Denmark, the Netherlands, France, Ireland, and the United Kingdom. Implicitly, Luxembourg is to be added, because it is not included in the figure due to its

Table 2.2.: EMU indicator (1994)

	Budget deficit	Debt indicator	CPI	Unempl. Rate	Current account deficit	EMU indicator
Austria	4,20	-1,33	3,00	6,00	1,10	12,97
Belgium	5,30	5,60	2,40	10,00	-4,80	18,50
Denmark	4,20	-0,36	2,00	10,20	-2,80	13,24
Finland	4,60	-1,92	1,10	18,70	-2,40	20,08
France	5,70	-3,07	1,70	11,30	-0,80	14,83
Germany	2,70	-2,88	3,00	7,30	1,80	11,92
Greece	13,10	3,41	10,90	10,20	0,80	38,41
Ireland	2,30	1,27	1,90	17,70	-7,90	15,27
Italy	9,70	4,64	3,90	11,80	-1,50	28,54
Netherlands	3,80	-0,10	2,80	10,00	-1,80	14,70
Portugal	7,10	-0,90	5,30	6,10	1,60	19,20
Spain	6,80	-1,60	4,70	22,40	1,00	33,30
Sweden	11,20	0,07	2,20	7,70	-0,40	20,77
United Kingdom	6,80	-2,89	2,50	9,40	0,40	16,21



Source: Own calculations.

large current account surplus, which would make appear it belonging to a group of its own. This group is quite homogeneous in terms of the EMU indicator, which ranges from 11.92 for Germany to 16.21 for the United Kingdom.

This group is followed closely by Belgium and Portugal, with the EMU indicator ranging between 18.5 and 19.2. Belgium has well-known problems with its public deficit, although it outperforms most other countries in terms of inflation and with its large current account surplus. Finland and Sweden follow closely. These two counries, however, are thefirst countries to perform weaker than the average value of the EMU indicator, which is 19.8.

After these groups there is a gap before the rest of the EU economies, Italy, Spain and Greece, follow with values for the EMU indicator between 28.5 and 38.4. The poor position of Italy is due to its poor public deficit and public debt performance. The situation is similar for Greece. Spain's poor performance in the EMU indicator is mainly due to its high unemployment rate.

The EMU indicator does provide a different picture of the convergence performance in Europe than the convergence criteria of the Maastricht Treaty. While the convergence criteria of the Maastricht Treaty would have been fulfilled by only two countries in 1994, Germany and Luxembourg, the EMU indicator suggests that a larger group of countries exhibit homogeneous macroeconomic performance. Depending on the concrete line to be drawn, a first group of countries in the third stage might consist of eight, may be even twelve EU countries.

Recently, in the spring of 1995, the British Government demanded "structural convergence", which aims at the inclusion of real convergence criteria[42]. In their view, the fulfilment of real economic criteria should be a requirement for progress to further stages of integration in addition to the monetary and fiscal convergence criteria explicitly laid down in the Maastricht Treaty. The claim for real convergence criteria has been based on Article 109j, where it says that "the results of the integration of markets, the situation and the development of the balance of payments on current account and an examination of the development of unit labor costs and other price indices" be taken into account of when assessing progress towards convergence, which leads the British Government to consider the Maastricht criteria as "a necessary but not a sufficient condition to justify a single currency"[43]. Or as the governor of the Bank of England, Eddie George, for example, suggested in a speech in Paris on 31st January that differences in unemployment - whether cyclical or structural - should be taken into account before deciding whether to push ahead with EMU.

The British attempt to define real economic convergence criteria did not, however, go beyond the additions mentioned above. A far more concrete proposal for real economic criteria was published in March 1995 by the British branch of the US investment bank Goldman Sachs. They argue that Article 109j

suggests not only that the EU should examine differences in real exchange rates from their long term equilibria, along with any balance of payments difficulties which this might entail, but also that the phrase "the results of the integration of markets" could be construed to include other real factors, such as the unemployment rate or the rate of growth of GDP. According to this proposal, the following four real conditions should be met in addition to the monetary and fiscal criteria in order to be able to participate in EMU.

(i) The current economic growth rate of an economy should not diverge by more than ± 1.5 percent from its long-run growth rate. The long-run growth rate is measured as the average over a 10-year period. This criterion is intended to ensure that the economic cycles of member countries are roughly synchronized.

(ii) A country's unemployment rate should not be more than 2 percentage points above the average of the EU. This is intended to ensure both that the amount of cyclical slack in different countries is similar and that the rate of structural unemployment - the NAIRU - in each country is close to the EU average. If the gap between the unemployment rate and the NAIRU is similar in each country, and the NAIRUs themselves are close together, we would observe that unemployment rates would be close together.

(iii) The deficit of the current account of the balance of payments should not exceed 2 per cent of GDP. This should primarily prevent EMU from causing a collapse in the exports of particular economies, because the devaluation option is then no longer available.

(iv) Competitiveness in relation to Germany must not have deteriorated by more than 10% since February 1987, the date of the last voluntary realignment. This criterion is designed to ensure that only countries, whose real exchange rate is close to the long-term equilibrium level, can join EMU.

Table 3 shows the extent to which the EU countries fulfil the real convergence criteria proposed by Goldman and Sachs. The degree of cyclical synchronization, as measured by the degree of convergence of real GDP, is quite high. A majority of member states would meet the criterion.

Similarly, with respect to the current account, this would not impose a problem for any of the countries, as no one is at present recording a deficit of more than 2 per cent of GDP. On competitiveness, those countries which fail the suggested criterion (Italy, Luxembourg, Sweden and Finland) all have greater competitiveness against Germany than permitted, mainly because of the post-ERM depreciations of the peripheral currencies in the last couple of years. This seems to be, according to Goldman and Sachs, less dangerous for a monetary union than the opposite case, even if it were to persist. With respect to unem-

ployment rate differences, most countries would meet the criterion, although there are wide differences in unemployment rates between Germany (7.3%) and several other member states, including France, Italy, and Spain, where unemployment rates are well into double digits.

To take into account of real convergence criteria would not throw up new obstacles for EMU. Strict numerology would suggest, as with the convergence criteria of the Maastricht Treaty, that only Germany and Luxembourg would have passed all preconditions in 1994.

Table 2.3: Real convergence criteria

	Real GDP	Unemployment rate (1994)	Current account deficit in % of GDP (1994)	Competitiveness against Germany (Feb. 1987= 100) End of 1994.
Proposed criterion	Within 1.5% of long-run growth rate[1]	12.9	Not less than -2.0	90-110[2]
Germany	2.3	7.3	-1.8	---
France	2.4	11.3	0.8	108.3
Italy	2.4	11.8	1.5	123.9
United Kingdom	3.9	9.4	-0.4	93.9
Spain	1.8	22.4	-1.0	109.5
Netherlands	2.4	10.0	1.8	108.3
Belgium	2.3	10.0	4.8	103.9
Denmark	4.6	10.2	2.8	103.1
Portugal	1.0	6.1	-1.6	---
Greece	1.0	10.2	-0.8	97.7
Ireland	5.0	17.7	7.9	106.3
Luxembourg	2.6	3.3	28.6	110.9
Finland	3.5	18.7	2.4	112.1
Sweden	2.0	7.7	0.4	113.9
Austria	2.8	6.0	-1.1	105.5

[1]Long-run growth rate is defined as the average growth rate between 1984 - 1994
[2]Competitiveness to Germany within 10% range of the level in February 1987 (the date of the last "voluntary" realignment). Higher numbers indicate better competitiveness relative to Germany.

Source: Goldman Sachs (1995)

In other words, whereas the EMU indicator points to a broader group of countries than adherence of the Maastricht Treaty's convergence criteria would suggest, the adoption of real convergence criteria would not have much of an influence on the eventual participants in EMU.According to the broader

interpretation of Goldman Sachs, a core group of countries - Germany, France, Luxembourg, Austria and the UK - would qualify on virtually all measures, be them real or nominal.

While the introduction of additional convergence criteria could provide for more credibility, it is contested whether they would be in line with Article 109j of the Maastricht Treaty. Although Article 109j indicates that a broader macroeconomic framework will be taken into account, the adoption of specific real convergence criteria, as in the proposal by Goldman Sachs, would probably involve a revision of the Maastricht Treaty.

Several proposals aim to strengthen the institutional setting in the European Union. The economic rationale comes from the aforementioned issues of time-inconsistency and credibility[44]. De Grauwe (1996) suggests to define and enforce a procedure for removal of the board of directors of the ECB should it fail to maintain price stability. Such a procedure would ensure future price stability, he argues, and would make the future ECB more accountable.

Gros (1995) suggests that countries that fail to satisfy the budgetary norms would not obtain a voting power on the board of directors of the ECB. Thus, his proposal foresees that countries like Italy and Belgium would be accepted into the union. However, as long as their budgetary house is not in order, these countries would not be allowed to take part in the decision process of the ECB. As a result, there should be less fear that heavily indebted countries may push the ECB to pursue too expansionary policies.

Hasse (1995b) makes a similar proposal. He argues that the excessive deficits procedure as determined in Article 104c of the Treaty is not sufficient to ensure budgetary discipline in EMU and suggests, as an extension to the procedure, a temporary suspension of the voting right of the government representative in the Council of Ministers[45]. He proposes to extend the catalog of sanctions to be applied in the case of an excessive deficit in Article 104c as follows: - *temporary suspension of the voting rights in the Council*[46].

Kenen (1995) proposes to use the debt criterion to condition the deficit criterion, not, as present, to stand beside it. A low debt-country might be made to satisfy the present test - a budget deficit not larger than 3 percent of GDP. A high-debt country might be made to satisfy a more stringent test - a deficit not larger than, say, 2 per cent of GDP. It would not be necessary, he argues, to alter the indents in Article 104c, which pertain to the existing deficit criterion, but the qualifications concerning the trend in the debt ratio could be dropped[47]. These changes are self-balancing, in that a high-debt country would have to run a smaller budget deficit. In addition, he proposes to change the present price-

stability test, which is in terms of relative inflation convergence, into an absolute one: A country's inflation rate must not exceed the smaller of two numbers: the one based on the showing of the three best performers and the other fixed at a certain percentage per year. Under this test, stage three can not start automatically in 1999 unless two or more countries have inflation rates below, say, 2½ percent. Thus, this kind of absolute restriction on inflation rate performance would contribute a more stringent test on prior nominal convergence.

De Grauwe (1994b) invokes the principle of free choice and suggests to let each country decide whether it wants to join[48]. The Community would declare that the monetary union will start at a specific point in time. Each country would then be free to join the union. Such a principle allows Europe, as he argues, to surmount the obstacles to EMU. If, for example, Germany would feel that it is not in its national interest to join the union and to abolish the mark, it would be free to stay out. More generally, member economies may evaluate the costs and benefits of their entry into monetary union. Authorities, assuming that they maximize a macroeconomic social welfare function, can calculate the risks associated with core-periphery tendencies and may then decide, whether it makes sense to participate in the union or not. A monetary union based on free decision of participants would constitute, per definition, an optimum currency area. No government would decide to enter into the third stage if the costs exceed the benefits for the country. The principle of free choice is not without problems, however, as noted by De Grauwe himself. Incomplete information and myopia may distort the decisions of member governments, which may additionally be influenced by domestic political pressure. Incentives for strategic behavior of political authorites also exist. High-inflation countries have, because of gains from lower inflation and efficiency gains from monetary union, an incentive to join the union. In contrast, for low-inflation countries, the participation in such a union becomes unattractive. Low-inflation countries will not want to be part of such a union if the welfare loss of the additional inflation exceeds the efficiency gains of the union. While free choice is an appealing notion, political and juridical aspects leave some doubts. Member states of the European Union, except for the United Kingdom and Danmark, are, however, in principle, obliged to enter monetary union. Straubhaar and Schmidt (1996), therefore, argue that while the principle of free choice is economically appealing, it is politically unrealistic. In contrast, they propose a broad interpretation of the Maastricht Treaty's convergence criteria. In principle, they argue, each country should be able to join monetary union as soon as it wants. Each country may evaluate, if it is at all in its national

interest to participate. However, the "necessary preconditions" according to Art. 109j need to be taken into consideration.

Overall, a number of different reform proposals have been stated in the literature. One set of proposals suggests to implement additional convergence criteria in order to make the convergence requirements more consistent with the goal of macroeconomic stability. However, taking explicitly into account of additional criteria would probably involve a formal revision of the Maastricht Treaty. Another set of proposals is directed towards strengthening monetary and fiscal institutions. To solve the aforememtioned time-inconsistency problems of monetary and fiscal policies, a strengthening of the ECB, in particular, is considered necessary. Finally, a self-selected monetary union is proposed. However, for political and juridical reasons, free choice does not seem to be a feasible policy option.

2.6. Concluding remarks

In this chapter, the transition process towards European monetary union is reviewed and the economic policy background of the subsequent empirical analyses discussed. The chapter started with a review of the design of the transition process as layed out in the Maastricht Treaty. The process is characterized by its long transition period and by its restriction on nominal macroeconomic indicators as barriers to entry into monetary union. It is emphasized that the Maastricht Treaty has created a transition-automatism to monetary union.

The subsequent analysis of the Maastricht Treaty's convergence criteria proceeds in two steps. First, the economic rationale of the convergence criteria is examined and, second, its restriction on nominal macroeconomic variables as barriers to entry is contrasted to characteristics of participants suggested by economic theory.

The main points of critique referring to the economic rationale of the criteria can be summarized as follows. Exchange rate volatility may not be the right indicator for economic convergence, since exchange rate movements are not necessarily determined by macroeconomic fundamentals. In advance of monetary union financial volatility is to be expected, which may imply speculative attacks due to self-fulfilling expectations. Expectations of a final realignment may lead to speculative crises before the final date. The long-term interest rate criterion does not necessarily provide accurate information on convergence, since observable interest rates do incorporate all sorts of expectations. Interest rates may indeed be

distorted by markets' expectations on the governments' own actions. With respect to inflation rates, the important determinant of price stability is the independence of the European Central Bank. The inflation rate criterion does not provide any additional guarantee with respect to price stability in the union.

The case for the fiscal criteria is similarly weak. Countries have to follow sustainable fiscal policies irrespective of the monetary regime. It is generally bad economic policy to apply rigid numerical restriction irrespective of the concrete situation of an economy.There is indeed a general conviction among economists that ex ante limitations on debts and deficits are not an appropriate way to secure the sustainability of a financial system. To secure a sustainable financial situation within EMU it seems most relevant to further strenghten the applicability of fiscal restrictions after the adoption of a common currency.

To derive "economic reference criteria", I refer to the theory of optimum currency areas. This theory implies that exchange rates can be fixed, and a monetary union is optimal, if the structure of the economies is "similar" and if goods and labor markets react flexibly to real economic changes. Moves towards monetary integration should therefore be undertaken if, first, the real economies of participating countries react to changes with similar rapidity and flexibility and, second, both the geographic and occupational mobility of labor is high. If these theoretical characteristics of an optimum currency area are compared with the nominal convergence criteria laid down in the Maastricht Treaty, a striking discrepancy between economic theory and political reality is to be noticed. The Maastricht convergence criteria are nominal criteria, whereas the characteristics suggested by economic theory relate to real economic activity. Thus, based on economic theory, the most relevant characteristics of participants in a monetary union refer to their real economic structure. Apart from being economically relevant, real convergence turns out to be desirable for political and juridical reasons, as Article 2 of the Maastricht Treaty itself includes social and economic cohesion as a fundamental principle the Community seeks to respect.

We conclude that while the transition process will probably culminate in the adoption of a common currency of at least two countries in Europe by the end of the century, the convergence strategy will not contribute to secure macro-economic stability in the future union. On the one hand, the monetary convergence criteria refer only to the transition period and their fulfillment is, therefore, irrelevant for future price stability. On the other hand, the budgetary norms, apart from being economically inconsistent, may be difficult to enforce due to political pressure. The concentration on nominal convergence is mistaken, because it does not take into account of real economic activity that will be most

relevant once the monetary union is achieved. Real economic divergence may lead to political pressure particularly in low-income, high-unemployment countries to increase public spending, which would contribute to higher public deficits and may involve a non-sustainable financial position in these countries. A non-sustainable financial position may, in turn, be associated with negative external effets on other member states. While the introduction of real convergence criteria would probably require a revision of the Maastricht Treaty, being therefore a non-feasible policy device, real economic convergence, as for its relevance in the monetary union, deserves to be assessed in more detail in order to evaluate the prospects of European monetary integration more carefully.

Endnotes

[1]Here, as in the rest of the dissertation, I use the terms "third stage" and "European Monetary Union" interchangeably.

[2] This section draws heavily on Kenen (1995).

[3]The gradual approach to monetary union has been subject of critique from economists. See, e.g., De Grauwe (1994a), Dornbusch (1990). It has been argued that a quick move to monetary union would be a major regime change and would thus induce the changes in economic behavior required for convergence. On the earlier debate between "monetarists", who argue in favor of a kind of shock therapy, and "economists", who support the gradual approach, see Giovannini (1990a), Gros and Thygesen (1992).

[4]The goals of stage one were [Gros and Thygesen, pp.350]: first, the member states should have taken steps towards independence of their central banks. Second, steps to prevent the monetary financing of public-sector budget deficits in each member state had to be taken. Third, all restrictions on capital movements were supposed to be removed. Fourth, all member states should have taken measures which would enable them to take part in the EMS. The passage to stage two was originally supposed to require the achievement of these goals.

[5]See Monticelli and Vinals (1993) for an analysis of the institutional design of the ECB.

[6]The Treaty goes on to say that the reports of the Commission and the EMI shall also examine the situation and development of the balances of payments and the development of unit labour costs and other price indices. This passage has been used to justify the examination of real convergence criteria, as will be discussed in more detail in section four.

[7]This, however, implies that a government may be obliged to enter the third stage although it possibly evaluates the economic costs to be higher than the economic benefits for its country. In such a case, the Maastricht Treaty would impose a kind of irrational behavior on the economy and on its citizens.

[8]Kenen (1995) points out that Germany cannot decide for itself whether to participate in stage three. While all decisions affecting the start of stage three will be taken by qualified majority voting, one decision thereafter, on the fixing of the values of the national currencies in terms of ECU, requires unanimity. The German government may thus be able to keep the monetary union from getting under way. Gros and Thygesen (1992, pp.392) note that the member states could, in principle, decide to renegotiate the EMU Treaty within the framework of the International Governmental Conference in 1996. They argue, however, that going back on the EMU Treaty would be a loss of momentum and prestige for European integration hard to imagine.

[9]Two protocols have been attached to the treaty, for Britain and Denmark, allowing them to opt out of stage three.

[10]Thygesen (1993b), for example, considers the present, wider bands as "normal" in the sense of the Maastricht Treaty. Crowley (1996) argues that the exchange rate criterion has been virtually dropped by the EMI.

[11]The German Council of Economic Advisers (1995) interprets the convergence criteria as a means to secure the functioning of the then newly created monetary system, to provide credibility for the European Central Bank, and to establish the Community as a "Stabilitätsgemeinschaft", directed towards overall macroeconomic stability [Sachverständigenrat, 1995, pp.246].

[12] For economic analyses of the transition process, see, e.g., Giovannini (1990a,b), Froot and Rogoff (1991), Mussa (1991).

[13]The convergence criteria have been widely analyzed by economists. De Grauwe (1994a) contains a comprising analysis. Other analyses include Begg et.al. (1991), Fratianni et.al.

(1992), Gros and Thygesen (1992). In German, contributions include Lesch (1993), Nicolaysen (1993), Mittendorfer (1994), Ohr (1993,1996), Petschnigg (1993), Hasse (1995b), Scharrer (1995a,b).

[14]Obstfeld (1986) provides a theoretical model for this kind of mechanism. Eichengreen and Wyplosz (1993) apply the model to analyze the EMS 1992-1993 crises. For alternative theoretical models of the occurrence of speculative attacks, see, e.g., Krugman (1979), Flood and Garber (1984), Wyplosz (1986), Lehment (1994).

[15]See, e.g., Gärtner (1995), Isard (1995) for reviews of monetary exchange rate models.

[16]This view was labelled "economist" in the earlier debate on European monetary integration.

[17]The Maastricht Treaty refers only to relative convergence of prices, i.e. relative to the three best-performing member states in terms of price stability. It has been argued, however, that absolute convergence of prices would have been more appropriate, because member states may still be threatened by absolutely too high inflation. See, e.g., Bean (1992) and Neumann (1992).

[18]This was indeed the rationale for including the criterion, as has been argued by Bini-Smaghi et.al. (1994).

[19]For formal econometric evidence on credibility and interest rates, see, e.g., Lindberg and Söderlind (1992), Rose and Svensson (1993) for empirical evidence, Svensson (1994) for a survey on exchange rate based stabilization.

[20]The classic references are Kydland and Prescott (1977), Barro and Gordon (1983a,b), and Rogoff (1985). For a survey of credibility and monetary policy games, see Blackburn and Christensen (1989); for a theoretical analysis of the EMS, see Giavazzi and Pagano (1988). See also Wagner (1995).

[21]The influence depends on the degree of economic and political independence of the ECB. There is a general conviction among economists, as the statute of the ECB resembles the one of the Bundesank, that no reason to expect the ECB to be more subject to political influence than the Bundesbank exists. See e.g. Fratianni and Von Hagen (1992), Gros and Thygesen (1992), Monticelli and Vinals (1993), Vinals (1994).

[22]For surveys of the literature on fiscal policy and EMU, see Commission (1990, 1993), Wyplosz (1991), and Van der Ploeg (1991). For analyses of seigniorage within the context of European monetary integration, see Gros (1989, 1992), Klein and Neumann (1990).

[23] The solution of the difference equation (5) is given by

$$b_t = [b_0 - def_t / (x+\pi)] (1-x-\pi)^t + def_t / (x+\pi)$$

The first term on the right-hand side of this equation refers to the out-of-steady state behavior while the latter term refers to the steady state behavior of public debt. Public debt is stabilized when the latter term equals 0.6. Correspondingly, if we subsitute 0.03 for the deficit, we need a rate of growth of nominal output of 0.05, thus 5% p.a, in order to achieve long-run stabilization of public debt.

[24] See also Pauly (1996) for additional simulation experiments.

[25]De Grauwe (1994b) suggest that the numbers were chosen so as to fit to the German economy, since during the 1980s the steady state debt level implied by Article 104c was consistent solely for Germany.

[26]Buiter (1992) evaluates the fiscal criteria as follows: "It should be obvious (but unfortunately does not appear to be so) that elevating these reference values (or indeed any reference values) to international norms or standards is unadultered economic nonsense, and dangerous nonsense to boot".

[27]The formulation of the criteria does give room for interpretation though, which may be used to take into account of these factors. However, no explicit adherence is made in the Treaty.

[28]The systemic effects and the influence on the international financial system could, as noted by the authors, be limited through international action that would need to relieve the defaulting government of its debt burden.

[29]Goldstein and Woglom (1992) provide empirical evidence for lacking ability of municipal bonds markets to anticipate the crisis of New York city in the 1970's. Frenkel and Goldstein (1991) point out that it is empirically not clear whether governments are sensitive to higher borrowing costs.

[30]In general, since government debt is denominated in nominal terms, unanticipated inflation is a lump-sum tax on debt holders. Therefore, a low-inflation policy is not dynamically consistent as long as the government has nominally denominated debt [Calvo, 1978].

[31]See Begg et.al. (1991), Bovenberg et.al. (1991), Kenen (1995), Van der Ploeg (1991), Wyplosz (1991). Eichengreen and Von Hagen (1995a,b) argue that only if monetary union was accompanied by fiscal centralization, a need for fiscal restrictions as a concomitant of EMU would arise.

[32] See, similarly, De Grauwe (1995).

[33] The following chapter contains a literature review and an empirical analysis of optimum currency areas in Europe.

[34]For surveys on the early literature on optimum currency areas, see Ishiyama (1975) and Tower and Willett (1976). More recent surveys are De Grauwe (1994a), Masson and Taylor (1993), and Tavlas (1993).

[35]See Tavlas (1993) and the references therein.

[36]The federalistic structure of Europe in relation with EMU has been subject of intense discussion among economists [e.g. Von Rompuy et.al. (1990)]. Empirical studies have tended to compare the fiscal structure of the United States with Europe, analyzing the extent to which the federalistic systems may be used for stabilization and cohesion purposes. Sachs and Sala-i-Martin (1992) found that in the United States the automatic income redistribution effects in the US offsets about 40% of regional income variations. Von Hagen (1992), using an alternative methodology that allows to separate a cohesion from a stabilization effect, obains a stabilization effect of about 9 cents per US$. Bayoumi and Masson (1994) estimate the stablization effect to be 31% and the cohesion effect at 22%. Italianer et.al. (1993) obtain 17% for the stabilzation effect. It follows from these studies that fiscal redistribution effects are important in the United States. It is clear that in Europe the potential for these kind of fiscal stabilization and cohesion is not given. The EU budget is far too narrow and effectively restricted for these purposes. Bayoumi and Eichengreen (1994) provide simulations that suggest that for the US, state budgets provided about 14 per cent of the fiscal offset to income fluctuations. Von Hagen and Hammond (1995), however, show that stabilizing asymmetric shocks around a common trend may amplify the variance of GDP for some member countries. They conclude that the EU is indeed better off without a fiscal stabilization system.

[37] The "new" theory of optimum currency areas incorporates modern concepts like rational expectations and a long-run Phillips-curve. The evaluation of the costs and benefits thereby changes. However, as the basic principle relating to the characteristics of participants remains unchanged, I do not go into detail of these additions. For analyses of these approaches, see Tavlas (1993), and De Grauwe (1994).

[38]The view that real convergence is a prerequisite for a monetary and customs union would also follow from the belief that the geographical location of economic activity is subject to centripetal forces arising from closer economic integration. Such forces might be due, for

example, to the attractiveness of an already highly industrialized center - with an established infrastructure and other positive external economies - for the location of economic activity [Myrdal, 1957; Perroux, 1959]. More recent work on geography and trade confirms that centralization, which would imply economic divergence, is more likely the greater the size of available economies of scale and the greater the size of the mobile manufacturing sector. Centralization, and real economic divergence, is less likely the greater the size and importance of transport costs [e.g. Krugman, 1991; Krugman and Venables, 1995]. For an application of these theories to the case of European monetary integration, see Krugman (1993).

[39]For an opposing view, see Buiter (1995).

[40] Only reform proposals that are related to economic convergence as precondition in the EU are reviewed. Therefore, neither the reduction of the "democratic deficit" in advance of monetary union, claimed by Williamson (1993) and Eichengreen (1994) nor the choice of the band width is taken into account [Ohr, 1996].

[41] These variables can be added because they are all dimensionless, i.e., they are all ratios or rates of change [see Gros and Thygesen, 1992 p.469].

[42]See, for example, the speech by Prime Minister John Major on 3rd February, quoted in: Neue Zürcher Zeitung (foreign edition), No.31, of 8th February 1995.

[43]Prime Minister John Major in a speech delivered on 3rd February 1995, quoted in Goldman Sachs (1995).

[44] In general, time inconsistency problems may be solved by either of four ways [Romer, 1996]: (i) reputation, (ii) delegation, (iii) punishment equilibria, and (iv) incentive contracts.

[45]See also Hasse (1996), where a fiscal cooperation oriented towards budgetary discipline is proposed.

[46]One drawback of this idea is, however, that it would, arguably, contribute to make the actions of the Council less accountable and could thereby lead to reduded political support for EMU. See Williamson (1993), who argues that the "democratic deficit" helps to explain the decline in political support for EMU.

[47] Italianer (1993) proposes to change the reference values. Article 104c of the treaty instructs the Council of Ministers, acting unanimously on a proposal from the Commission, to adopt 'the approprate provisions' to replace the protocol that contains the reference values for deficits and debt. He interprets this passage to mean that the Council can change the reference values.

[48] Eichengreen and Frieden (1993) similarly view a dash to EMU as the first-best scenario on economic grounds. Alesina and Grilli (1993) argue, based on a formal model, that if a self-selected group of countries form a monetary union, they will have an incentive to exclude other countries that are not as strongly committed to price stability. This would lead to divisive forces associated with such a multi-speed approach.

3. Optimum currency areas: one or many in Europe?

3.1. Introduction

A currency area between two or more countries means that those countries agree to irrevocably fix their exchange rates. Thus, the central point about a currency area is that, when countries proceed to join one, they give up the possibility of allowing the exchange rate between their own currency and those of the other members of the union to vary. The theory of optimum currency areas analyzes the economic costs associated with the adoption of a common currency (see Chapter 2).In essence, exchange rates can be fixed, and a monetary union is optimum, according to this theory, if the structure of the economies is "similar" and if goods and labor markets react flexibly to real economic changes[1].

The recent empirical literature on optimum currency areas has tended to focus on the degree of symmetry of shocks [e.g. Weber, 1990; Bayoumi and Eichengreen, 1993; Neumann and Von Hagen, 1994; Jordan, 1994]. The idea is that if economies are structurally similar, shocks should be evenly distribued. If this is the case, common policies can be used. If shocks are unevenly distributed and thus affect member countries differently, in a system of flexible exchange rates, the exchange rate can adjust through depreciations or appreciations of the currencies. In contrast, in a fixed exchange rate system the economies need to adjust through alternative mechanisms. I compare the symmetry of the shocks among European countries with the symmetry of the shocks affecting the United States and Canada, in order to provide additional evidence on the importance of asymmetric shocks affecting the European economies in a monetary union. In doing this, a bivariate analysis of annual output and unemployment rate data from 17 major industrialized countries over the 1969 to 1994 period is carried out. There are compelling reasons for undertaking a joint analysis of output and unemployment. According to many standard macroeconomic theories, if the unemployment rate is above its natural level, then it will be expected to fall as a result of induced higher than normal rates of output growth. The unemployment rate should thus provide valuable information on the deviation of output from its trend level. The use of data from 17 countries allows to examine the robustness of the results and to compare differences and common regularities in dynamic behavior across countries.

The cyclical relation between output and unemployment has been studied by several authors recently. Blanchard and Quah (1989) have studied the dynamics

of output and unemployment for the U.S. assuming that the first disturbance has a long-run effect on output while the second does not. They label the one having a long-run effect on output a "supply" disturbance and the one having no long-run effect on output a "demand" disturbance and conclude that demand disturbances make a substantial contribution to output fluctuations at short- and medium term horizons. Bonjour and Kugler (1993) apply this approach to output and unemployment data for six countries (USA, Germany, UK, France, Japan and Switzerland) and conclude that the dynamic effects of demand shocks support the traditional "Keynesian" view of business cycles. Evans (1989) examines U.S. output and unemployment, assumes a recursive structure, in which the unemployment rate is determined by the growth rate of output, and obtains an important relative contribution of demand shocks[2].

The rest of the chapter is structured as follows. In Section 2, the empirical literature on optimum currency areas is reviewed. In Section 3 a stochastic macroeconomic model is developed that builds the formal background for the subsequent statistical analysis, which is contained in Section 4. Section 5 provides an economic interpretation and Section 6 concludes the chapter.

3.2. Review of empirical evidence on optimum currency areas

A number of empirical analyses dealing with aspects of the optimum currency area in the EU countries and international labor market flexibility exist, of which the main contributions are discussed below. As the purpose is to make the subsequent empirical analysis comparable to others, the review is restricted to a non-critical survey of empirical work on optimum currency areas in Europe.

Poloz (1990) compares the adjustment of real exchange rates between regions of Canada, as an existing monetary union, with the adjustment in the EU countries and finds lower real exchange rate volatility in the EU countries. He therefore concludes that a monetary union in Europe would not entail higher costs than in Canada. Neumann and Von Hagen (1994) carry out a corresponding analysis for the regions of Germany. They come to the conclusion that a monetary union would be possible for a core group of countries (Austria, Belgium, France, Germany, Luxembourg and the Netherlands). On the other hand, a monetary union comprising all EU countries would entail high costs. A study by De Grauwe and Heens (1993) reaches a similar conclusion. Bayoumi and Eichengreen (1993) compare the correlation of shocks to aggregate demand and supply in twelve EU countries and eight regions in the USA. They estimate that shocks in the EU countries are less correlated. Accordingly, a monetary union in

Europe would entail relatively high economic costs. At the same time, they surmise that a monetary union in a core group of countries would give rise to costs comparable to those in the regions of the United States. Bini-Smaghi and Vori (1992) consider that the structure of production in EU countries is more diversified than in the regions of the USA, so that asymmetrical shocks are less likely to occur in Europe than in the USA. This finding is confirmed by Cohen and Wyplosz (1989), who show that Germany and France are primarily influenced by symmetric permanent shocks. A monetary union between these countries would therefore be feasible. Eichengreen (1992b) examines various indicators for a monetary union - real exchange rate variability, labor mobility, relative share prices - and compares the European performance with that of the USA and Canada. According to his findings, a monetary union in Europe would entail higher costs than in the existing monetary unions in the USA and Canada. De Grauwe and Van Haverbecke (1993) compare the adjustment mechanism at the regional level with that at the national level in a number of EU countries and find that labor mobility plays an important role at the regional level, whereas at the national level adjustment occurs mainly via changes in real exchange rates. They argue that a monetary union in Europe would have to be accompanied by increased labor mobility. In the absence of such mobility, a monetary union would be in danger of triggering polarisation tendencies. Erkel-Rousse and Mélitz (1995) contribute an interesting aspect to the discussion of asymmetric shocks. They apply a structural Vector Auto Regression (VAR) approach to data from six European countries (France, Germany, Italy, the Netherlands, Spain, United Kingdom). First, they find that the correlation of shocks across countries is indeed very low. This finding is in line with the evidence provided, for example, by Bayoumi and Eichengreen (1993) and points to the empirical relevance of asymmetric shocks. However, in a second step, they analyze the importance of fiscal and monetary policies as a measure of response to asymmetric shocks. They find, first, that fiscal policies contribute heavily to output performance in all countries except Germany. Second, more interestingly, they find that monetary policies do not contribute significantly to output performance in any country except Germany. This latter result indicates that monetary policy in these countries has no value as a stabilization device and implies that the adoption of a common currency for those countries would impose much lower economic costs than previously believed. This piece of work thus points to the fact that the mere existence of asymmetric shocks is not a sufficient argument against a currency union, because monetary policy may not be a useful tool for response to asymmetric shocks. Funke (1995) analyzes the incidence of aggregate demand and supply shocks in EU countries

and regions of Germany. He uses a bivariate VAR with prices and output and identifies the underlying orthogonal demand and supply shocks using long-run restrictions. The results show that the correlation of shocks among EU countries is lower than within Germany, which leads him to adopt a skeptical view on the prospects of EMU.

In sum, the available empirical analyses are divided on the question of whether the EU countries constitute an optimum currency area. The findings appear to depend mainly on the reference variable chosen. However, more recent analyses tend to suggest that a multi-speed monetary union would be preferable[3].

Regional labor mobility and flexible labor markets are important to the efficiency of a monetary union. In their examination of the mechanism for adjusting to changes in the demand for labor, Blanchard and Katz (1992) found that in 51 regions of the USA adverse regional shocks were mainly offset by the migration of labor to other regions. Decressin and Fatás (1995) extend this analysis to European regions According to their findings, changes in labor demand in Europe are not offset by labor mobility but mainly by an age or gender-specific decline in labor participation rates. Eichengreen (1993) examines regional unemployment in England and Italy and shows that adjustment to changes in relative prices occurs in much the same way as in the regions of the USA. As regards to the usefulness of inter-country labor mobility as a cushioning device for shocks in EMU, these and other studies find that labor movements across EU countries are very limited and significantly smaller than across EU regions[4]. Relatively low mobility of labor is thus a potential handicap for the EU as it progresses towards monetary union. Whereas European integration might enhance this channel over time, the US experience suggests that this is likely to take several decades. In addition, evidence provided for the Nordic countries by Fischer and Straubhaar (1995) seems to suggest that in these countries liberalization of labor mobility has led to a decrease in labor movements.

3.3 A stylized model

To provide a formal background for the subsequent statistical analysis, in this section a simple open economy macroeconomic model is applied, being based on Alogoskoufis (1992, 1994). Consider an open economy that produces one internationally traded commodity. Output is produced by a short-run production function of the type

$$y_t = \beta l_t + \mu_t \qquad (3.1)$$

where y is the logarithm of output, l is the logarithm of employment, and μ_t is a measure of productivity. Capital is assumed fixed, as for the short-run nature of the production function.β is the exponent of labor and is less than unity. Productivity follows a random walk with drift.

(3.2) $$\mu_t = g + \mu_{t-1} + \kappa_t$$

where g is the average rate of growth of productivity and κ_t is an identically and independently distributed random shock. Firms determine employment by equalizing the marginal product of labor to the real wage. This yields the following employment equation:

(3.3) $$l_t = -\frac{1}{1-\beta}(w_t - p_t - \mu_t)$$

where w is the logarithm of the nominal wage and p is the logarithm of the price level. The nominal wage is set at the beginning of each period and remains fixed for one period [Fischer, 1977]. The objective of wage-setters is to stabilize expected employment around a target employment level $\bar{n}$. Thus, wages in each period are set to minimize

(3.4.) $$E_{t-1}(l_t - \bar{n})^2$$

where E_{t-1} is the operator of rational expectations, conditional on information available up to the end of period t-1 and $\bar{n}$ denotes the target level of employment. The minimization of (4) is subject to the labor demand function (3). From the first-order conditions for a minimum of (4) subject to (3), the nominal wage is given by

(3.5) $$w_t = E_{t-1}p_t + E_{t-1}\mu_t - (1-\beta)\bar{n}$$

Using equations (5) and (3), we get the following expression for employment:

(3.6) $$lt = \bar{n} + \frac{1}{1-\beta}(p_t - E_{t-1}p_t + \kappa_t)$$

An unanticipated rise in prices reduces the real wage and causes firms to employ more labor. Thus aggregate employment rises above its equilibrium rate On the other hand, an unanticipated shock to productivity increases the marginal product of labor. Thus employment rises above the target level $\bar{n}$ and output rises on account of both the higher employment and the higher productivity. Subtracting the expression for the employment level from the labor force, and using the approximation that $u \approx n - \bar{n}$, after some manipulations, we get the following expression for the determination of unemployment:

$$u_t = \bar{u} - \frac{1}{1-\beta}(\Delta p_t - E_{t-1}\Delta p_t + \kappa_t) \tag{3.7}$$

where $\bar{u} = 1 - \bar{n}$ is the "natural" rate of unemployment in the model. Equation (7) is the expectations augmented Phillips curve [see, e.g., Franz, 1991]. Unemployment deviates from its equilibrium rate only to the extent that there are unanticipated shocks to inflation or productivity. Anticipated shocks to inflation and productivity are reflected in wages and do not affect unemployment.

The demand side of the economy is decribed by the following equations:

$$y_t = m_t - p_t + \mu_t \tag{3.8}$$

$$p_t = e_t + p^*_t \tag{3.9}$$

$$m_t = m_{t-1} + \nu_t \tag{3.10}$$

Equation (8), an expression for aggregate demand, is a reformulation of the quantity equation of exchange. Following Blanchard and Quah (1989), the productivity shock μ_t is assumed to affect aggregate demand directly, which may be due to an adjustment lag in domestic absorption. The economy is assumed to be a price-taker. Domestic prices are related to the world price level by a purchasing power parity relation, as in equation (11). The money stock is assumed to follow a random walk, as described by equation (12).

To close the model, we need to determine the evolution of the nominal exchange rate and the foreign price level, p*. For simplicity, we assume that the exchange rate and the foreign price level follow random walks.

$$e_t = e_{t-1} + \eta_t \tag{3.11}$$

$$p_t^* = p_{t-1}^* + \eta_t \tag{3.12}$$

where η_t is an identically and independently distributed foreign shock. This is in line with empirical analyses indicating that exchange rate movements are unpredictable and not directly related to economic fundamentals [Meese and Rogoff, 1983]. We assume that the shocks are independent and uncorrelated both across time and across types of shocks.

Equations (1) to (12) completely describe the demand and supply side of the economy. By substituting equations (9), (11), and (12) into the Phillips-curve relation, we obtain a reduced form for the rate of unemployment, being determined only be random shocks.

$$(3.13) \qquad u_t = \bar{u} + \Psi(2\eta_t + \kappa_t) \qquad \text{with} \quad \Psi = -\frac{1}{1-\beta}$$

According to equation (13), the unemployment rate is affected by unanticipated demand shocks and supply (productivity) shocks. As for the stationarity of the unemployment rate, shocks cause deviations from its long-run equilibrium rate only temporarily. Correspondingly, by using equations (8) to (12), we obtain an expression for output growth in terms of random shocks.

$$(3.14) \qquad \Delta y_t = \nu_t + 2\eta_t + \kappa_t$$

Output growth is determined by both domestic (money supply) and foreign demand (price) shocks, and by productivity shocks. As output is nonstationary, shocks do have a permanent effect on the level of output and a transitory effect on its rate of growth.

This standard macroeconomic model implies that unemployment is stationary, with shocks having only a transitory impact on the level of unemployment. Output, in contrast, is nonstationary, therefore, while shocks may have a permanent effect on the level of output, deviations from its average growth rate remain temporary. Both unemployment and output are affected by demand and supply disturbances.

3.4. Statistical analysis

In this section, I analyze the dynamic effect of shocks to output and the rate of unemployment using a bivariate structural VectorAutoRegression (VAR).

First, the stochastic properties of output and unemployment are analyzed, in order to determine whether they are in line with the predictions from the model

presented above. Univariate unit-root tests, Granger-causality tests and tests for cointegration are carried out. Unit-root tests are performed in order to determine the order of integration of the time series [e.g. Granger and Newbold, 1986]. Causality tests are used to determine the causal structure of the variables [Granger, 1969, 1988]. Tests for cointegration are applied in order to determine, whether a long-run equilibrium relationship among the variables exist which would need to be taken into account within the subsequent VAR analysis.

Secondly, a structural VAR analysis is performed.

The GDP data come from the OECD National Accounts, while the unemployment rate data are taken from the OECD Labour Force Statistics and OECD Economic Outlook, 1996. The data set comprises annual data for the period 1969 to 1994.

3.4.1. Stochastic properties of output and unemployment

Economic time series are usually following a trend, which often implies a non-stationary stochastic component. As a preliminary step, for model specification, it is thus useful to examine the degree of integration of the time series involved. In this section, therefore, first, the stochastic properties of real output and unemployment are examined. After a presentation of the results from univariate unit-root tests, Granger-causality tests and, finally, tests for cointegration are carried out.

3.4.1.1. Unit root tests

Univariate tests of whether the series are integrated of order one are reported in Table 1. The table reports the results from Augmented-Dickey-Fuller tests, where the following regression has been run for each series[5]:

$$\Delta x_t = \alpha + \beta x_{t-1} + \sum_{i=1}^{i=p} \Delta x_{t-i} + \varepsilon_t \qquad (3.15)$$

The null hypothesis that the variable x_t is integrated of order one - or has a unit root, or a stochastic trend - amounts to the null hypothesis that $\beta = 0$. The number of lags has been determined according to the Schwartz-criterion [see Lütkepohl, 1991]. The first two colums in the table give the t-value of the constant α and the slope β in the regression, respectively. The Dickey-Fuller test statistic reported is the t-ratio of the slope but, since the distribution is non-standard, rather than the standard t-distribution statistics, the critical values tabulated in Fuller (1976) are valid.

The test results indicate that output series in all countries except for Greece are nonstationary, integrated of order one.

Table 3.1.: Unit root tests

Country	Variable	Constant α	Slope β	Number of lags
Austria	y	0,16	-1,37	1
	u	0,11	-0,91	1
Belgium	y	0,32*	-2,07	1
	u	0,21*	-2,13	1
Canada	y	0,42*	-1,83	1
	u	0,33*	-2,21	1
Denmark	y	0,13	-0,8	1
	u	0,37*	-2,35	1
Finland	y	0,39*	-2,11	1
	u	0,21	-1,3	1
France	y	0,31*	-2,02	1
	u	0,15*	-1,45	1
Germany	y	0,15	-0,76	1
	u	0,08*	-0,14	2
Greece	y	0,48	-3,18 *	1
	u	0,13	-1,64	1
Ireland	y	0,21	-1,29	1
	u	0,07	-0,46	1
Italy	y	0,33	-1,84	1
	u	0,17	-1,16	1
Luxembourg	y	0,01*	0,14	2
	u	0,03	0,07	2
Netherlands	y	0,11	-0,78	1
	u	0,32*	-2,77	1
Portugal	y	0,21	-1,56	1
	u	0,36*	-1,89	1
Spain	y	0,19	-1,45	1
	u	0,15	-1,26	1
Sweden	y	0,21	-1,22	1
	u	0,51*	-3,07 *	1
UK	y	0,28*	-1,92	1
	u	0,17	-0,55	1
USA	y	0,12	-0,47	1
	u	0,86	-2,97	1
* indicates significance at 5 per cent significance level. Critical values from Fuller (1976).				

Source: Own calculations

For the unemployment rate series the results tend to accept the hypothesis of a unit root in all countries except for the United States and Sweden, where the tests reject the unit-root hypothesis.

3.4.1.2. Granger-causality tests

To examine the causal structure between output and unemployment, I test for Granger-causality between output growth and the rate of change of the unemployment rate[6]. To test for Granger-causality, Δy_t is regressed on two lags of itself and two lags of Δu_t. An F-test is used to assess the validity of the causal structure. Granger-causality of output growth on unemployment growth involves the combined hypothesis that the lags of the unemployment growth rate are not significant in the output equation and the lags of output growth are significant in the unemployment equation. Unemployment is said to cause output, if the lags of output growth are insignificant in the unemployment equation and the lags of the unemployment growth rate turn out to be significant in the output equation.

Table 3.2.: Granger-causality tests

Country	Unemployment does not cause output	Output does not cause unemployment
Austria	F(2,24)=0.48	F(2,24)=10.73***
Belgium	F(2,24)=1.95	F(2,24)=2,81*
Canada	F(2,24)=5,73**	F(2,24)=2,47
Denmark	F(2,24)=2,23	F(2,24)=2,10
Finland	F(2,24)=4,81**	F(2,24)=12,39***
France	F(2,24)=1,34	F(2,24)=2,68*
Germany	F(2,24)=1,96	F(2,24)=3,82**
Greece	F(2,24)=1,12	F(2,24)=5,99***
Ireland	F(2,24)=1,48	F(2,24)=0,42
Italy	F(2,24)=3,72**	F(2,24)=2,48
Luxembourg	F(2,17)=4.00**	F(2,17)=2,46
Netherlands	F(2,24)=0.29	F(2,24)=1,43
Portugal	F(2,24)=1.01	F(2,24)=6,37***
Spain	F(2,24)=4,44**	F(2,24)=3,13*
Sweden	F(2,24)=4,62**	F(2,24)=1,81
United Kingdom	F(2,24)=5,61**	F(2,24)=10,22***
USA	F(2,24)=4,91**	F(2,24)=5,38**

Estimation is by ordinary least squares. * denotes significance at 10 per cent level;
** denotes significance at 5 per cent level; *** denotes significance at 1 per cent level.
Numbers in parantheses refer to the degrees of freedom in the regression.

Source: Own calculations.

The test results given in Table 2 are quite unambiguous. In most countries in either one or both directions the hypothesis of no causality can be rejected at a 5 per cent significant level. The exceptions are Denmark, Ireland and the Netherlands, where the null hypothesis of no causality is accepted in both cases. In general, however, there tends to be a feedback and instantaneous causality relation between output growth and unemployment growth.

3.4.1.3. Tests for cointegration

The cointegration concept introduced by Granger (1983) and formalized by Engle and Granger (1987) influenced the analysis of nonstationary time series. The importance for econometric modelling became evident when Granger showed that a time series model with cointegration has a representation as an error-correction model (ECM) and vice versa. In an ECM the changes in the variable depend on the deviation from some equilibrium relation. Cointegration concepts could be given then a meaningful economic interpretation in terms of sluggish adjustment to some long-run equilibrium described by economic theory.

Here, the main motivation for an analysis of cointegration is a purely conceptual one: two cointegrated variables, being modelled wrongly as first differences (or levels) of both variables, can be shown to have a noninvertible Moving Average (MA)-part. Therefore, the impulse response functions of the data could not be obtained or, correspondingly, an impulse response function derived from a wrongly specified VAR process would give misleading results [see Lütkepohl, 1991, Chapter 11].

I employed the cointegration-test procedure developed by Johansen (1988) and Johansen and Juselius (1990)[7]. The procedure involves estimating the following Vector Error Correction Model (VECM):

$$\Delta Z_t = A_0 D_t + \sum_{i=1}^{i=p} \Delta\Gamma_i Z_{t-i} + \Pi Z_{t-1} + \varepsilon_t \qquad (3.16)$$

where Z_t is a 2x1 vector $Z_t = [y_t , u_t]'$and D_t =[intercept]. The cointegration tests determine the number of cointegrating vectors. That is, they are used to decide on the order and elements of the matrix π. If the rank of the matrix is equal to two, that is equal to the total number of variables in the model, the vector process Z_t is stationary. If the rank of the matrix is equal to $r < 2$, there exists a representation of π such that $\pi = \alpha\beta'$. The matrix β is the cointegrating matrix

and has the property that $\beta'Z_t$ is integrated of order zero, while Z_t is integrated of order one.

Table 3.3.: Tests for cointegration

Country	Eigenvalue	Likelihood-Ratio	5 per cent critical value[a)]	1 per cent critical value	Hypothesized No. coint. vectors
Austria	0.09	2.42	15.41	20.04	None
	0.02	0.15	3,76	6.65	At most 1
Belgium	0.21	8.62	15.41	20.04	None
	0.13	3.16	3,76	6.65	At most 1
Canada	0.40	15.75*	15.41	20.04	None
	0.15	3.84*	3.76	6.65	At most 1
Denmark	0.13	3.92	15.41	20.04	None
	0.04	0.83	3.76	6.65	At most 1
Finland	0.19	8.41	15.41	20.04	None
	0.15	3.71	3.76	6.65	At most 1
France	0.16	6.05	15.41	20.04	None
	0.08	1.93	3.76	6.65	At most 1
Germany	0.15	4.46	15.41	20.04	None
	0.03	0.63	3.76	6.65	At most 1
Greece	0.31	12.24	15.41	20.04	None
	0.15	3.74	3.76	6.65	At most 1
Italy	0.31	9.95	15.41	20.04	None
	0.06	1.39	3.76	6.65	At most 1
Ireland	0.19	7.77	15.41	20.04	None
	0.11	2.85	3.76	6.65	At most 1
Luxemb.	...	...	...	...	...
Holland	0.29	7.78	15.41	20.04	None
	0.01	0.01	3.76	6.65	At most 1
Portugal	0.32	10.74	15.41	20.04	None
	0.07	1.79	3,76	6.65	At most 1
Spain	0.41	12.34	15.41	20.04	None
	0.01	0.05	3.76	6.65	At most 1
Sweden	0.17	4.40	15.41	20.04	None
	0.01	0.02	3.76	6.65	At most 1
UK	0.35	12.65	15.41	20.04	None
	0.10	2.55	3.76	6.65	At most 1
USA	0.22	6.01	15.41	20.04	None
	0.01	0.20	3.76	6.65	At most 1

a) Critical values are from Osterwald-Lenum (1992).

Source: Own calculations.

The results of applying the Johansen procedure for testing the order of the matrix Π are given in Table 3. Two eigenvalues are printed in the second column of this table. Likelihood Ratio-statistics for testing the hypothesis that there are at most r cointegrating vectors are given in the third column. The critical values for a 5 per cent and 1 per cent significance test are obtained from Osterwald-Lenum (1992). The tests indicate, that in all countries except for Canada, cointegration is strongly rejected. Therefore, we conclude that there is no long-run equilibrium relationship between output and unemployment to be found.

Overall, the analysis of the stochastic properties indicates that output and unemployment are nonstationary time series, containing a unit-root. There exists in general a causal relationship between the two variables although a cointegrating relationship could not be detected. While the test results hint to a unit-root in unemployment, I stick to the assumption of stationary unemployment within the subsequent VAR analysis, for two reasons. First, a nonstationary unemployment rate seems economically rather implausible in the long-run. With the unemployment rate increasing along a stochastic trend, policy measures will most probably be adopted at one stage to reduce unemployment. Secondly, the low power of unit-root tests is well-known [Charemza and Deadman, 1992]. They sometimes tend to fail to discriminate between a stationary alternative with a structural break and a stochastic trend [Campbell and Mankiw, 1991]. In particular, as for the limited number of observations due to yearly data, the test results may be seriously flawed [see also Bonjour and Kugler, 1993]. As for the large number of countries, and since a common solution for all countries in order to be comparable had to be taken, I decided to maintain the assumption of stationary unemployment rates.

3.4.2. Structural VAR analysis

In this section, a bivariate structural VAR-analysis is carried out[8]. First, the methodological background is discussed and second, impulse response functions are used to analyze the dynamic behavior of goods and labor markets in the seventeen industrialized countries.

3.4.2.1. Methodology

A VAR system may be considered as a specified reduced form of a set of dynamic simultaneous equations describing the economy [Genberg and Swoboda,

1985][9]. The bivarate VAR is characterized by the following autoregressive equation system[10]:

$$(3.17) \qquad \begin{bmatrix} A_{11}(L) & A_{12}(L) \\ A_{21}(L) & A_{22}(L) \end{bmatrix} \cdot \begin{bmatrix} \Delta y_t \\ u_t \end{bmatrix} = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$$

L refers to the lag operator which transforms a time series as $L^i Z_t = Z_{t-i}$ and A(L) is an autoregressive polynomial of order p. An error term ε_{it} is also present and represents those influences which cannot be accounted for otherwise by the model. Thus, for example, ε_{1t} can be thought of as the current innovation to Δy_t, that is, that part of Δy_t that could not have been predicted based on the information set available at time t. In the equation system (17) each of the two variables depends on its own lagged values as well as on the other variables' lagged values. The equation system determines the joint reaction of the endogenous variables output growth and unemployment to the innovations ε_{1t} and ε_{2t}. The Wald moving average (MA)-representation is obtained by inverting equation (17) to get:

$$(3.18) \qquad \begin{bmatrix} \Delta yt \\ ut \end{bmatrix} = \begin{bmatrix} B_{11}(L) & B_{12}(L) \\ B_{21}(L) & B_{22}(L) \end{bmatrix} \cdot \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \equiv B(L)\, \varepsilon_t \quad [11]$$

The MA-representation will be used for the computation of impulse responses over time in a variable due to a shock in itself or in the other variable. We assume that innovations to each variable are linear combinations of the contamporaneous "fundamental shocks", i.e. $\varepsilon_t = S\nu_t$, for a unique non-singular matrix S, with $SS' = \Sigma$, where Σ denotes the variance-covariance matrix of ε. Given the Wald moving average representation, it follows that the dynamic behavior of Δy and u is described by the following model:

$$(3.19) \qquad \begin{bmatrix} \Delta y_t \\ u_t \end{bmatrix} = \begin{bmatrix} C_{11}(L) & C_{12}(L) \\ C_{21}(L) & C_{22}(L) \end{bmatrix} \cdot \begin{bmatrix} v_{1t} \\ v_{2t} \end{bmatrix} \qquad \text{with } C(L)=B(L)\, S$$

It is assumed that the vector $Z_t = [\Delta y_t, u_t]'$ is a stationary stochastic process, which is, in line with the macroeconomic model of section two, driven by two types of exogenous forces: (i) demand shocks, represented by a sequence $\{v_{1t}\}_{t=0}^{t=\infty}$, and (ii) supply shocks, represented by $\{v_{2t}\}_{t=0}^{t=\infty}$. Both ν_{1t} and ν_{2t} are assumed to have zero mean and to be serially and mutually uncorrelated at all leads and lags. As is usual in this kind of analyses, their variances are normalized

to unity. Two additional identifying restrictions are needed. I assume that B(0)=I. In addition, it is assumed that $C_{12}(0)=0$. This implies that the matrix S is lower triangular, and can thus be uniquely determined from the Choleski factorization of Σ. Since an estimate of B(L) can be obained from the OLS estimation of equation system (17), the knowledge of S allows to recover an estimate of C(L).

The economic interpretation of these identifying restrictions is that supply shocks are restricted not to have a contamporaneous effect on output. In other words, firms are assumed to maintain a fixed stock of capital in the short-run which is adjustable with a lag of one period only. The cost structure of the firms may, however, still affect production in period t+1. On the other hand, demand shocks by definition affect the level of output contemporaneously. Demand shocks affect output through their influence on the level of aggregate demand immediately. These identifying restrictions are essentially in line with the stylized model presented in section two of this chapter. While demand shocks affect output directly and contamporaneously, supply shocks are transmitted through their immediate impact on labor markets and affect goods markets only indirectly with a lag.

3.4.2.2. Impulse response functions

The impulse response functions and the corresponding 5% confidence intervals are given in Figures 1 to 17. The responses over 15 years to a one-standard deviation shock are simulated. For Luxembourg the response over 8 years is displayed, since data are available only from 1976. The confidence intervals are obtained using a method described in Doan (1992), which is based on a Monte Carlo procedure suggested by Kloek and Van Dijk (1978). This procedure uses the fact that the theoretical distribution of the VAR coefficients can be derived [Zellner, 1971]. Repeated random draws from this distribution are made, and for each draw the implied moving average coefficients are calculated. In this way a number (equal to the number of draws) of values is obtained for each moving average coefficient, which allows the calculation of means and standard errors of the latter. The number of draws was 1000[12].

For the USA and Canada, the peak of the response of output to a shock to the output equation is reached within approximately 1 to 2 years. Whereas the demand shock levels off with practically no effect after about 4 years, the supply shock raises unemployment in Canada and the USA after 15 years still by about half a percentage point.

The response of unemployment to a demand shock is a mirror-image to the shape of the response of output to a demand shock. Both demand and supply shocks do affect unemployment in the short-run to medium-run, for about 3 to 4 years, while leaving the natural rate of unemployment unaffected. The shape of the responses in the European countries turns out to be similar. The dynamic response of output to a demand shock is hump-shaped, in general, although the inital positive effect on output is less visible than in the North-American countries. In the long-run, demand shocks do not affect output in the European countries.

The unemployment rate is reduced in the short-run by about one percentage point in response to a demand shock in Europe. In the medium-run, after about 4 years, the effect of the shock is vanished. In the long-run, the unemployment rate is affected neither by demand nor by supply shocks. Thus, overall, the dynamic response of output and unemployment to demand and supply shocks turns out to be quite similar in Europe and North-America.

Figure 1: Austria

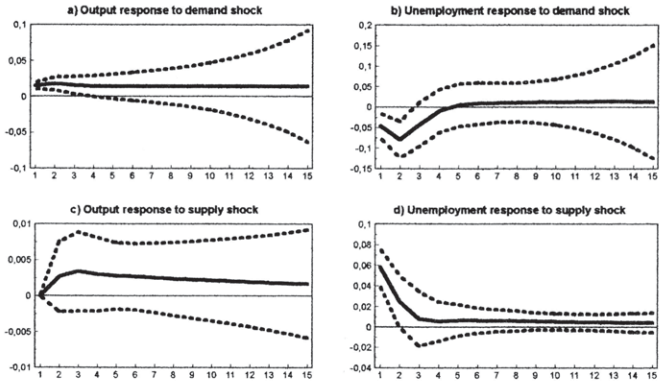


Figure 2: Belgium

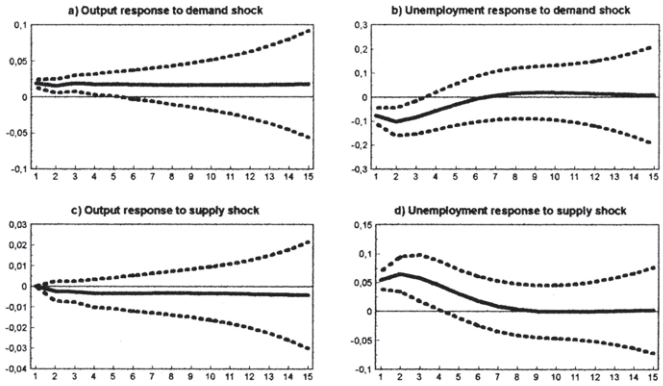


Fig. 3: Canada

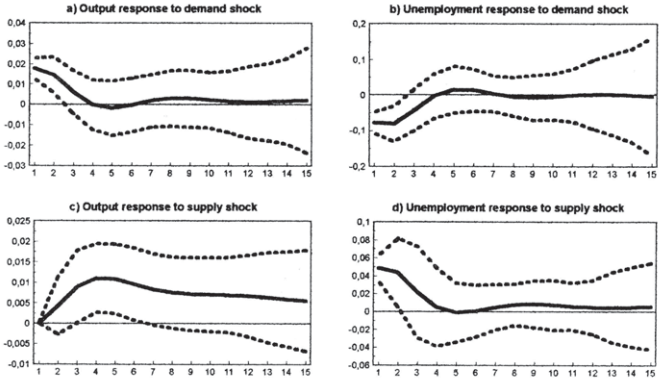


Figure 4: Denmark

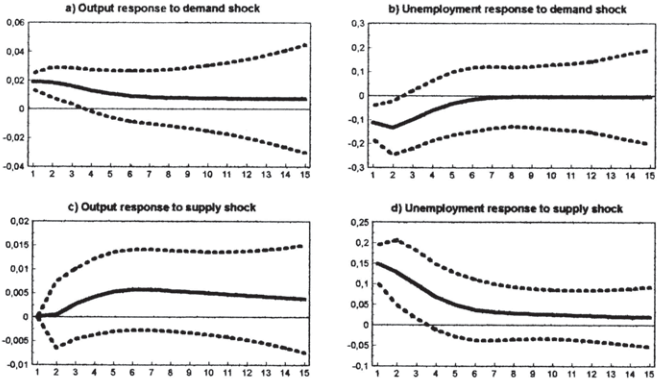


Figure 5: Finland

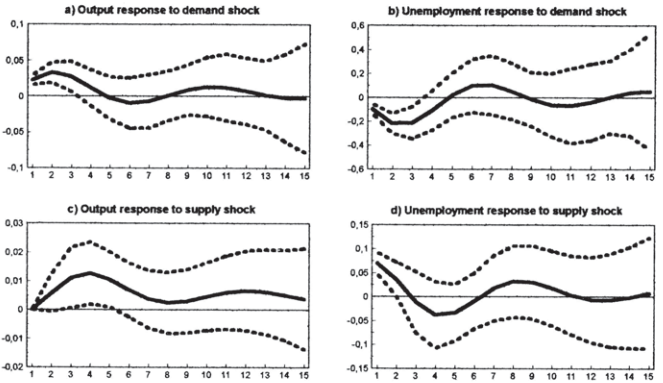


Figure 6: France

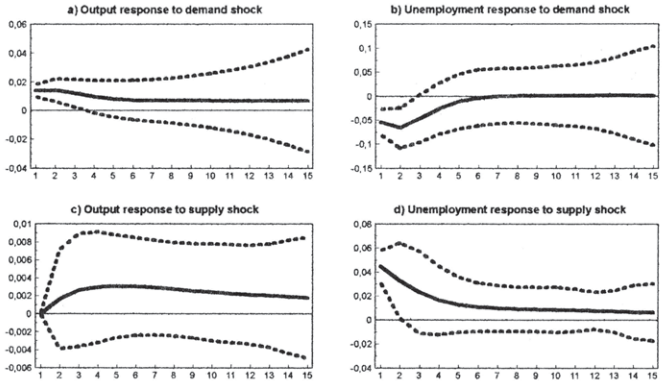


Figure 7: Germany

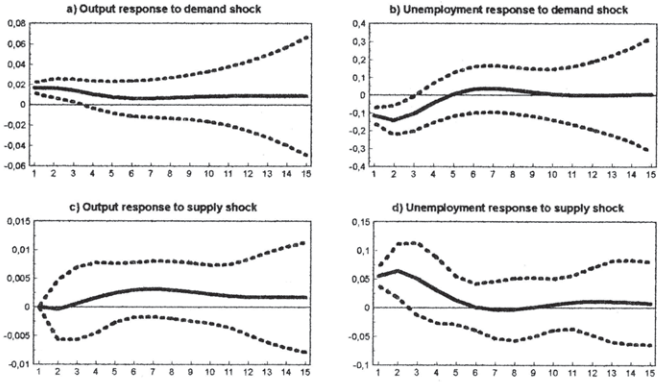


Figure 8: Greece

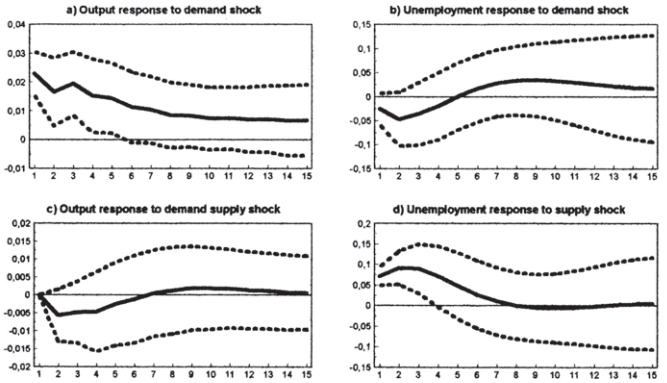


Figure 9: Ireland

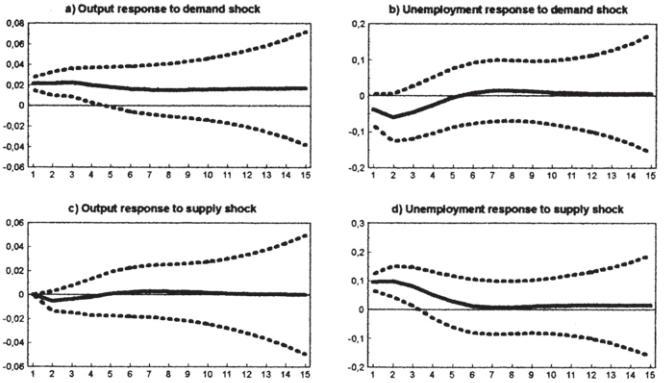


Figure 10: Italy

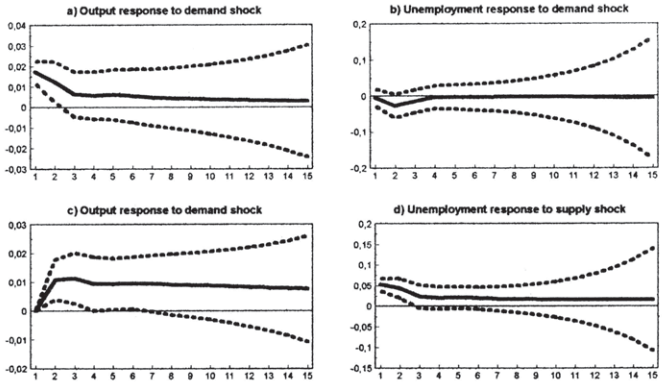


Figure 11 : Luxembourg

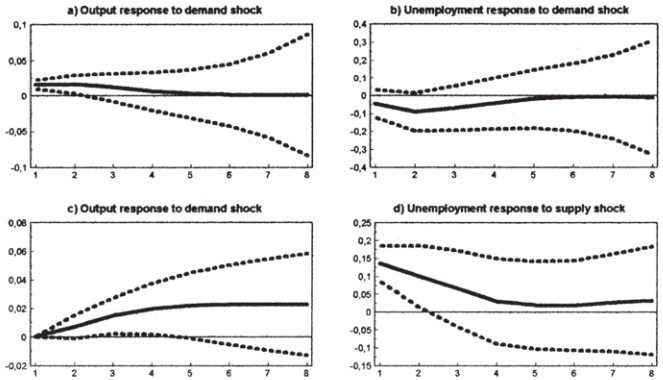


Figure 12: Netherlands

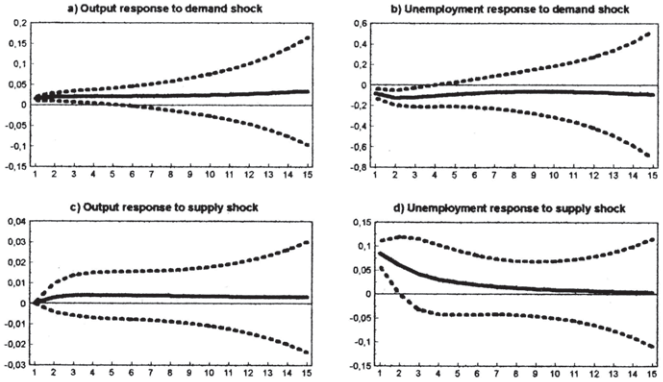


Figure 13: Portugal

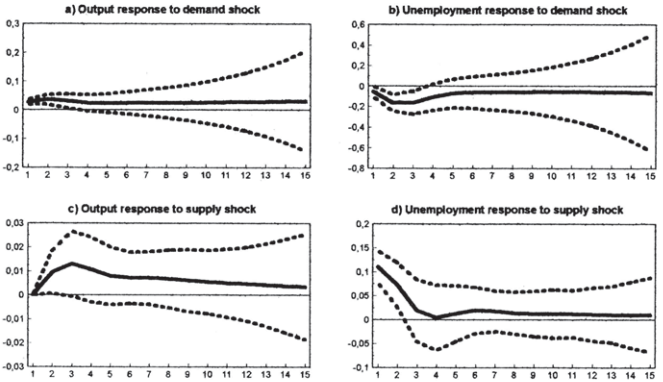


Figure 14: Spain

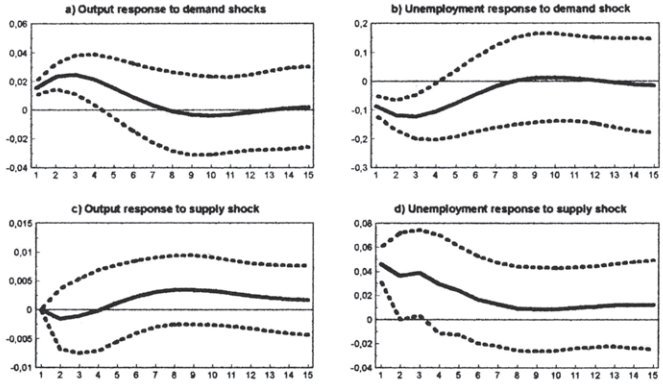


Figure 15: Sweden

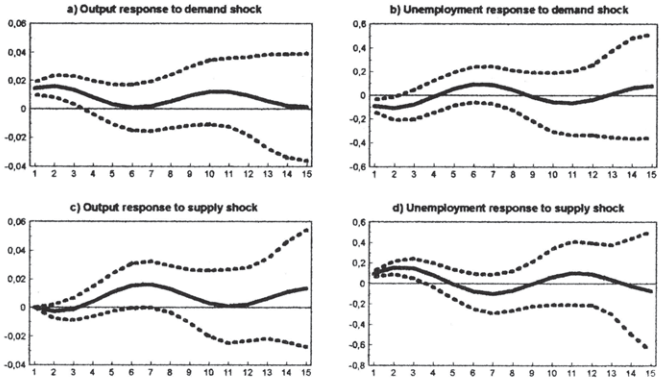


Figure 16: UK

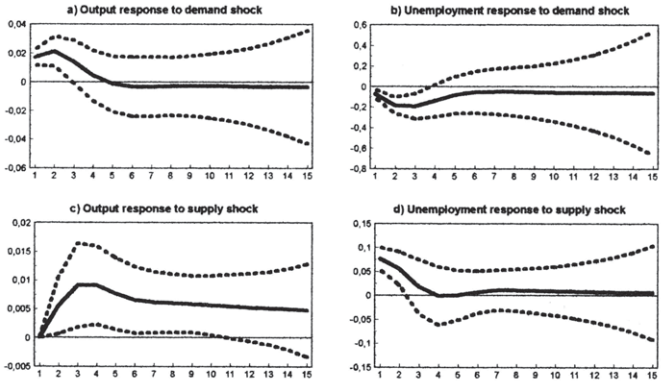
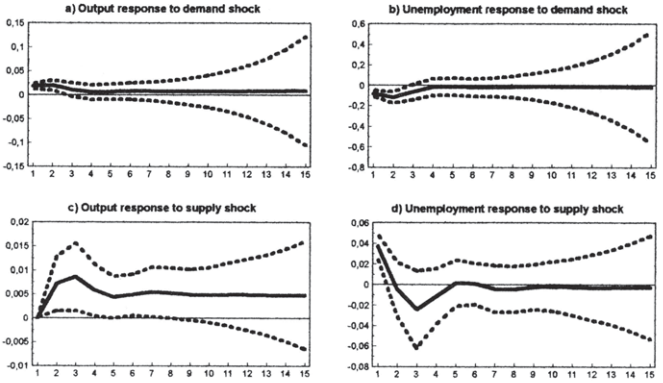


Figure 17: USA



Source: Own calculations.

It must be emphasized that the results must be interpreted with particular caution, as for the high degree of uncertainty associated with the impulse responses, documented by the confidence bands in the figures, which may be due to the limited number of observations available.

3.5. Economic interpretation

In this section, an economic interpretation to the results obtained in the statistical anyalsis is provided. I first attempt to justify the interpretation in terms of demand and supply shocks. In addition, I examine the degree of symmetry of shocks in the EU and in North-America.

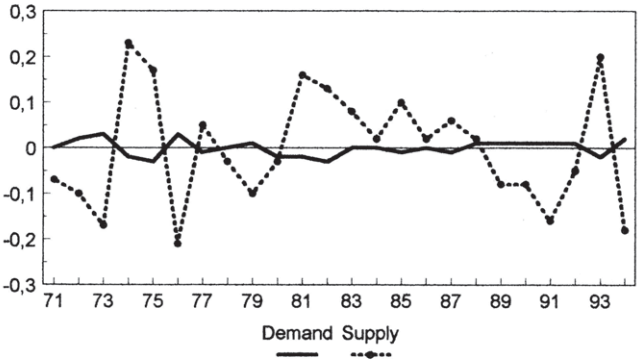
3.5.1. Demand and supply shocks

In order to analyze the interpretation of the random shocks in terms of demand and supply disturbances, in Figure 18, the estimated demand and supply shocks are displayed for the case of Germany[13]. Are these "demand" and "supply" shocks in line with conventional wisdom? First, the supply shock turns out to be much more volatile than the demand shock. This seems to be in line with the frequently stated argument that supply shocks have been most important for business cycles in industrialized countries since the 1970's [e.g. Bruno and Sachs, 1985]. Demand side management may indeed be expected to be more stable, as monetary and fiscal policies are directed to stabilize the economy, and as structural changes in economic policies tend to be anticipated without having a major effect on the economies. Looking at the figure in more detail, we may identify the first oil price shock in the 1970's, which seems to be captured by the model, however, with a lag of about two years. The rebound, due to demand side policies implemented by the Social Democratic Party at that time did not affect the economy significantly. Apparently, it had in the mid 70's a small, though transitory, impact on the economy. Next, we may clearly and accurately identify the impact of the second oil price shock in 1978 and 1979. The participation in the European Monetary System and tight monetary policies conducted by the German central bank, on top of a change of government in 1982, provided a negative demand side impulse in the early 1980's, which is also captured by the model.

At the same time, the improved cost situation of firms due to lower inflation and a more conducive policy environment provided a positive supply side impulse on the economy. In the mid 80's, the third oil shock occcured with oil

prices falling by about 40% within two years, thereby the cost situation of firms being improved significantly. German unification provided a positive demand-side impulse to the economy in the end of the 1980's until about 1992, as the demand by the eastern part of Germany raised aggregate demand and improved sales of firms.

Figure 3.18: Demand and Supply shocks in Germany



Source: Own calculations.

In the beginning of the 1990's, however, increasing competitive forces and a rising tax burden on individuals and firms induced a negative supply-side impulse and finally dampened the unification boom, as is captured by the model, although the positive spike of the supply shock in 1993 is difficult to interpret.

Overall, the "demand" and "supply" shocks seem to describe the macroeconomic development in Germany quite accurately. While this analysis refers only to a single country, the interpretation fits quite well to economic activity in Germany so that this should, arguably, be similar in the other countries.

3.5.2. Symmetry and asymmetry of shocks in Europe and North-America

With respect to European monetary integration, the correlation of shocks between countries is of interest. The correlation of demand and supply shocks across countries is taken as indicator for the distribution of shocks across countries. In a monetary union, sharing a common currency, national central banks can neither conduct independent monetary policies nor depreciate/appreciate their currencies in response to shocks affecting the economies. As far as shocks are hitting the economies evenly, this does not imply a problem for the national economies. However, if shocks are affecting only a specific country or region in the union, alternative adjustment instruments like relative wage movements or fiscal transfers have to be used. Therefore, it is of interest to analyze the degree of symmetry between the shocks having affected the economies in the past.

In assessing the magnitude of disturbances to the European economies, a standard of comparison is needed. I used the symmetry of shocks affecting the United States and Canada as reference point. The United States and Canada are known to be closely integrated econmies with historical trade connections and close monetary ties with the Canadian Dollar being pegged to the US-Dollar. Additionally, both countries have participatee, together with Mexico, in a North American Free Trade Union (NAFTA). Thus the comparison can be taken to indicate whether the European countries would be better suited to form a common currency area than a hypothetical common currency area between the United States and Canada[14]. Although the introduction of a common currency is both likely to induce major structural changes and to change the underlying economic model of rational agents forming their expectations, so that the evidence is subject to the Lucas-critique [Lucas, 1976], the relation of shocks in the past may provide an indication for the probability of European economies being affected by asymmetric shocks in the future monetary union. In the upper-diagonal of Table 4, the correlation of supply shocks and in the lower-diagonal the correlation of demand shocks across countries are given. The results are in general plausible. Demand shocks are more symmetric than supply shocks. Brandner and Neusser (1992) suggest the rule of thumb that cross-correlation coefficients between detrended series exceeding $2/\sqrt{T} = 2/\sqrt{25} = 0.4$ in absolute value are significant at the five per cent level[15]. Based on this rule of thumb, the cross-correlation coefficients between Germany and the other EU-countries, for example, are in more than half of the cases statistically significant. Having in mind the discus

Table 3.4.: Correlation of demand and supply shocks.

	Demand																
Supply	A	B	DK	SF	F	G	GR	IR	IT	LUX	N	Port.	Esp	Swe	UK	Can	USA
A.		0,77	0,42	0,25	0,72	0,73	0,07	0,22	0,71	0,17	0,72	0,6	0,75	0,36	0,21	0,07	0,31
B	0,57		0,19	-0,08	0,75	0,67	0,04	0,14	0,69	0,41	0,74	0,54	0,61	0,29	-0,02	0,15	0,31
DK	0,12	0,11		0,4	0,45	0,52	0,46	-0,05	0,27	0,01	0,41	0,35	0,44	0,43	0,5	0,06	0,21
SF	0,11	-0,07	0,13		0,23	0,07	0,48	0,12	-0,04	0,16	-0,01	0,36	0,27	0,48	0,37	0,14	0,16
F	0,53	0,74	0,13	0,06		0,69	0,11	0,33	0,65	0,34	0,65	0,61	0,64	0,44	0,3	0,17	0,42
G	0,48	0,5	0,55	-0,27	0,39		0,27	0,26	0,66	0,3	0,78	0,58	0,5	0,35	0,38	0,3	0,65
GR	0,41	-0,04	0,14	0,2	-0,01	0,27		0,04	-0,2	0,29	0,12	0,24	0,04	0,45	0,34	0,16	0,33
IR	0,44	0,66	0,06	0,05	0,46	0,27	-0,04		0,1	-0,07	0,19	0	0,07	0,13	0,05	0,02	0,29
IT	0,01	0,35	-0,39	-0,37	0,2	-0,13	-0,22	0,24		0,35	0,76	0,33	0,44	0,39	0	0,23	0,29
LUX	0,25	0,24	0,17	-0,19	-0,01	0,37	0,02	0,18	0,03		0,35	0,1	0,02	0,46	0,16	0,23	0,32
N	0,46	0,83	0,13	-0,22	0,53	0,5	-0,07	0,54	0,3	0,04		0,3	0,49	0,35	0,19	0,35	0,57
Port.	0,21	0,49	0,11	0,21	0,62	0,22	-0,17	-0,02	0,12	-0,02	0,29		0,55	0,21	0,46	0,07	0,29
Esp.	0,53	0,45	0,38	-0,06	0,61	0,68	0,26	0,11	-0,14	0,15	0,36	0,39		0,31	0,17	0,09	0,11
Swe	0,21	0,01	0,22	0,61	0,12	0,07	0,17	-0,07	-0,37	-0,12	-0,05	0,14	0,28		0,31	0,19	0,24
UK	-0,08	0,15	0,47	0,28	0,18	0,13	-0,09	0,32	0,05	-0,03	0,13	-0,15	0,1	0,09		0,28	0,49
Can	0,47	0,45	0,09	0,02	0,44	0,38	0,13	0,31	0,14	-0,21	0,57	0,22	0,22	0,08	0,09		0,83
USA	0,19	0,35	0,18	-0,02	0,32	0,41	0,18	0,17	-0,15	-0,25	0,51	0,05	0,24	0,15	0,18	0,73	

Source: Own calculations.

sion on a multi-speed EMU, we compared regions in Europe with the United States and Canada, given in Table 5. Shocks across sub-groups of countries are found to be more symmetric than for the whole group of countries.

Table 3.5: Average correlation of shocks by regions

Region	Demand shocks	Supply shocks
All countries	0.34	0.2
EU-15	0.32	0.16
Central-European EU-countries (Austria, Belgium, France, Germany, Ireland, Luxembourg, Netherlands, UK)	0.4	0.35
Southern-European countries (Greece, Italy, Portugal, Spain)	0.23	0.04
North (Denmark, Finland, Sweden)	0.44	0.32

Source: Own calculations.

Demand and supply shocks affecting a group of Central-European EU-countries (Austria, Belgium, France, Germany, Ireland, Luxembourg, Netherlands, UK) are found to be more symmetric than for the whole group of countries, although still less symmetic than for a group of North-European (Denmark, Finland, Sweden) countries or for North-America (Canada, USA).

As for the higher symmetry of shocks in smaller country-groups, we consider a multi-speed monetary union, around a Central-European core group, as a feasible alternative. The relatively high symmetry of shocks affecting the Southern-European countries may suggest a "Southern-European monetary union" as well, i.e. a common currency for those countries. Theoretically, if these countries are taken to form an optimum currency area, efficiency gains from sharing a common currency are exploited. Through the efficiency gains from introducing a common currency in the peripheral group, further losses of competitiveness could be avoided so that this would be a preferable situation compared to a postponed third stage. Thus, the implementation of a North-European and a Central Europe currency, or, more generally, the implementation of regional currency blocks, could potentially be a preferrable path to an overall common currency in Europe.

3.6. Concluding remarks

In this chapter, we have analyzed output and unemployment fluctuations of 17 countries. The results can be summarized as follows: first, the dynamic behavior

of output and unemployment are found to be relatively similar in the European and in the North-American countries, although demand and supply shocks in Europe tend to have somewhat more persistent effects on output and unemployment. Second, demand and supply shocks affecting the North-American countries are more evenly distributed than those affecting the European countries. Third, the degree of symmetry of shocks is higher among sub-groups of countries than for the whole group of European countries. Fourth, the 15 EU member countries do not form an optimal currency area as a whole, as shocks affect economies relatively unevenly.

The results point to the problem of adjustment to asymmetric shocks with rigid labor markets in a monetary union. The evidence indicates that the speed of adjustment to shocks in the European economies examined seems slightly slower than in the North-American economies and that the United States and Canada, at least if based on the symmetry of shocks affecting both economies, would be better suited to form a common currency area than the European countries[16]. However, of those European countries in the sample, a central European group, as well as a North-European group, were affected relatively similarly by shocks, so that the adjustment costs of sharing a common currency within these countries would be lower than for all European countries together.

We conclude, therefore, that a multi-speed European Monetary Union would be more sensible than a full monetary union consisting of all EU-member countries. We suggest the implementation of currency blocks, i.e. monetary unions within sub-groups of European countries. The economic costs to adopt a common currency for these smaller country groups are smaller than for the European countries as a whole. Additionally, it could avoid further losses of competitiveness of these countries and thus help for the later entry into the third stage of EMU.

Endnotes

[1] For a critical discussion of the theory of optimum currency areas, see Mélitz (1995).

[2] A number of studies have analyzed the importance of demand and supply shocks. As these studies use other variables, they are not referred to here. For an extensive overview on this line of research, see Tichy (1994).

[3]For a similar interpretation of the evidence on optimum currency areas, see De Grauwe (1995).

[4]For additional empirical evidence, see, e.g., Bayoumi and Prasad (1995), who similarly emphasize differences in labor market adjustment between U.S.regions and European countries.
[5] See, e.g., Charemza and Deadman (1992), for a review of unit-root tests.

[6]See Granger (1969). Textbook discussions of this type of test can be found, for example, in Hansen (1993), or Maddala (1992).

[7] For reviews, see Charemza and Deadman (1992), Hansen (1993), Dickey and Rossana (1994).

[8] See, for instance, Sims (1980), Sargent (1979). Cooley and LeRoy (1985) contains a critique of VAR methods. Early contributions to the literature on structural VAR's are Bernanke (1986) and Blanchard and Watson (1986). As in all these references, here it is relied on short-run identifying restrictions. The restrictions used here resemble those of Galí and Hammour (1991). Blanchard and Quah (1989), in contrast, use long-run identifying restrictions. Galí (1992) applies both types of restrictions. For a survey on structural VAR's, see Giannini (1992), Tichy (1994).

[9] The Vector Error Correction model used in the previous section is a special form of a VAR model that allows for long-run relationships between nonstationary variables.

[10] Here, as in the other empirical analysis in Chapter 4, it is relied on reduced form specifications. One disadvantage of reduced form specifications is that policy instruments, which could in principle be used to support the convergence process, are not modelled explicitly. Thereby, the natural rate of unemployment in this case ends up being determined by stochastic innovations, which would in practice be hardly convincing for a policymaker. An alternative approach, that is more appropriate to take into account of policy instruments, would be to apply structural econometric models [for a detailed analysis of different econometric modelling approaches, see Uebe and Fischer, 1992]. As here the emphasis is on the dynamic response to different shocks, and due to the simplicity of the approach, I decided in both empirical analyses to stick to reduced form specifications. I am thankful to Prof. G.Uebe for making me aware of this point.

[11]Where $\begin{bmatrix} B_{11}(L) & B_{12}(L) \\ B_{21}(L) & B_{22}(L) \end{bmatrix} = \begin{bmatrix} A_{11}(L) & A_{12}(L) \\ A_{21}(L) & A_{22}(L) \end{bmatrix}^{-1}$

[12] Note that the scale in the graphs varies, which makes the comparison of them in terms of the height difficult.

[13] See Funke (1994), for a similar analysis.

[14]Bayoumi and Eichengreen (1993) use a similar approach comparing regions of the United States with countries of Europe. Funke (1995) compares regions in Germany with countries of the European Union.

[15] In contrast, Harvey and Jaeger (1993) have suggested that for T=25 cross-correlations have to exceed at least 0.5 to reduce the chance of finding spurious cross-correlations.

4. Technology, convergence and growth in the European Union

4.1. Introduction

Disparities of income per capita across regions and countries have been a matter of concern for the European Community since its inception[1]. The objective of reducing disparities across regions in the Community is laid down already in the preamble of the Treaty of Rome. In 1987, the Community received in the Single European Act an explicit competence for undertaking a regional policy aimed at reducing disparities. The Maastricht Treaty on European Union, moreover, in its Article 2, includes economic and social cohesion as a fundamental principle the Community seeks to respect. Moreover, Article 130a states that the Community shall aim at reducing disparities between the levels of development of the various regions.

There has been a renewed interest in the economic analysis of growth and convergence, which has been associated with both the objective of convergence across countries and regions becoming politically acceptable and with new developments in theories of economic growth. Theories of economic growth were, up to very recently, regarded as optimistic with respect to the distribution of income. They tended to suggest that the distribution of income would become more similar over time, so that poor countries converged to the income level of rich countries. In contrast, the literature on endogenous growth proposed that the gap between rich and poor countries would remain persistent over time, so that poor countries always remained poor and rich countries remained rich.

From an economic policy point of view, the issue of growth and convergence in Europe is indeed particularly interesting and relevant, for two reasons: first, regional convergence or divergence determines the usefulness of regional economic policies attempting to equalize the distribution of income [Sala-i-Martin, 1995]. Second, European monetary integration might contribute to convergence - or divergence - itself by increasing factor mobility or trade among participating countries. Economic integration may indeed have an effect on aggregate growth of GDP in the Community economy. To the extent that this is favourable, higher growth can be expected to improve welfare. There is, however, the fear that a full-fledged European Monetary Union (EMU) will widen the existing regional inequality in per capita income within the European Union (EU). Monetary integration, and its implicit obligation to assure convergence of nominal indicators such as inflation and interest rates, will entail

restrictions on macroeconomic policy that are more onerous for the less-prosperous countries of the Union [Begg and Mayes, 1993]. Together with unemployment problems, these concerns have already given rise to a doubling in real terms of European Community (EC) structural funds devoted to regional and social policy in the period 1988-1992 [Abraham and Von Rompuy, 1992]. These kind of arguments indeed lie at the heart of the real convergence debate in the context of European Monetary Union.

The present chapter deals with these issues within the framework of an empirical analysis of the relation between technological differences, convergence and growth across EU countries. Three main goals are associated with this chapter. For one, it aims to provide a review of empirical analyses and of the relevant theoretical background. In addition, the stability of the convergence processes across time and across countries is examined. Finally, we analyze the reason for the apparent instability of the growth and convergence process in Europe. Based on endogenous growth theories (and on technological catch-up approaches), a possible explanation is the presence of technological differences, which are tested for within a structural econometric framework. Thereby, the chapter contributes to analyze convergence of living standards in the EU member states, thus focusing on long-run aspects of real economic convergence.

We may first ask if technological differences, as for the high degree of integration and economic cooperation among EU countries, are really plausibly relevant for economic development in Europe. Several kind of theoretical and empirical considerations suggest that they might indeed be relevant, even in such an integrated area like the EU. Already on a national level, formal comparisons of productivity levels frequently uncover wide variation among firms in the same manufacturing industry. Even in a service industry such as retailing, firms like K-Mart and Wal-Mart use very different technologies to provide their service, with very different outcomes in terms of profitability and returns on equity [Romer, 1995]. These persistent differences are difficult to explain if the technology that each uses is a public good. Empirical evidence on the effect of innovation on output and productivity tends to support this skepticism. Here, a consensus has emerged that innovation has a significant effect on productivity at the level of the firm and industry [Cameron, 1996]. Griliches (1988), for example, suggests that the elasticity of output with respect to R&D is generally found to be much lower than the social rate of return to R&D. Recent work on the effect of geography on spillovers, moreover, indicates that technologically-intensive industries tend to be more localized than other industries, and that information flows locally more easily than at a distance [Jaffe et.al., 1993; Audretch and Feldman, 1994].

Technological differences across economies are even more relevant than on the national level, in particular, if we think of technology in a broad sense, that is, representing resource endowment, climate and institutions, which supposedly vary across countries [Barro and Sala-i-Martin, 1995]. Technological differences would imply that convergence and growth processes differ across economies and would thereby contribute to explain the apparent instability of growth and convergence across time and across countries in Europe [e.g. Larch, 1994; Armstrong, 1995]. To test for the hypothesis of technological differences, I use cross-country data, which allows to apply a prolongued data set (1950 - 1992), and which enables to analyze the principal determinants of growth and convergence suggested by modern theories of economic growth.

The remainder of this chapter is organized as follows. In Section 2, the theoretical background is reviewed and the main implications for convergence are summarized. Three modern theories of economic growth are discussed in this section. Theories of technological catch-up argue that inefficient use of technology may lead to a process of convergence, depending on the degree of economic development in the economy. Neoclassical growth theories predict convergence due to decreasing returns to scale. Endogenous growth theories, in contrast, maintain that economic growth may be influenced by factors like market size, economies of scale and institutional structure, so that differences in living standards would possibly persist. Some controversy has also arisen with respect to the empirical assessment of convergence. A correct assessment of convergence is important, because whether convergence actually occurs across regions and countries may indeed shed some light on the relevance of new growth models. In view of this controversy, several empirical concepts of convergence have been developed recently, which are reviewed in Section 3. In addition, formal, mathematical concepts of convergence are contrasted with empirical convergence concepts. Section 4 provides a review of the empirical literature, concentrating first on papers dealing with the evolution of growth and convergence among world economies and then turning to empirical work using data from European regions. Section 5 analyzes the stability of the growth and convergence processes in Europe using descriptive statistical methods. The purpose of this analysis is to underline the argument that convergence has not been stable, neither across time nor across countries. In order to compare the performance of both measures, income per capita and labor productivity are used. In Section 6 a descriptive growth model is developed and used to derive a convergence regression equation. Section 7 contains an econometric analysis of technology, convergence and growth in the EU. The econometric model is based

on the stylized growth model developed above and concentrates on output per capita as measure for living standards. Section 8 summarizes the chapter, relates the empirical evidence to the European integration process, and provides conclusions.

4.2. Theoretical background

In this section, three modern theories of economic growth are reviewed and their implications for economic convergence are summarized. Theories of technological catch-up argue that inefficient use of technology may lead to a process of convergence, depending on the degree of economic development in the economy. Neoclassical growth theories predict convergence due to decreasing returns to scale. Endogenous growth theories, in contrast, maintain that economic growth may be influenced by factors like market size, economies of scale and institutional structure, so that differences in living standards would possibly persist.

4.2.1. Catching-up and falling behind

The notion of a catching-up effect can be traced back at least to Gerschenkron (1952) [cited in Hansson and Henrekson, 1994a,b], who maintained that, where a country's growth prospects are concerned, an advantage may lie in relative backwardness in terms of productivity[2]. The general idea of the catching-up hypothesis is that in terms of productivity backward countries will have an opportunity to embark on a catching-up process by imitating and borrowing superior production techniques from the more advanced economies cheaper and faster than the original discovery and testing. By imitating production techniques from the more advanced economies, the lagging ones may reduce the distance to their own technological frontier. The growth potential of lagging countries is not solely because of the possibility of replacing obsolete capital with best practice equipment. In addition, there is a chance to adopt advanced management practices, better marketing strategies etc. As a result, we ought to expect technologically less developed countries to experience faster productivity growth than the technologically leading ones. In the literature on the catching-up hypothesis, however, this possibility is not regarded as necessarily realisable. Another necessary condition for the catching-up factor to be operative is a sufficient degree of "social capability", as has been emphasized by Abramovitz (1986, p.388). Abramovitz distinguishes between potential and realized catching-

up. The former is due to the gap between the leader countries and the backward countries, which are thus able, through imitation, to increase productivity. Realized catching-up is the rate of exploitation of potential catching-up, which is caused by diffusion of knowledge, the rate of structural change, the accumulation of capital and the expansion of demand. He points out that a country has to have the "social capability" and "technological congruence" to catch up to the leader. Institutional commitments might also act as a constraint on convergence. However, once countries have reached a threshold level of development in terms of "social capability", the process of catching-up will be driven by interactions between leaders and followers via flows of capital, final goods and applied knowledge. Accordingly, the catching-up effect may be expected to be strongest in technologically backward but socially advanced countries. A major problem with the concept of social capability is its imprecision. Abramovitz (1986) enumerates a number of factors that are important determinants of a country's social capability: the level of education, the organisation of firms, openness to foreign competition, the ease by which new firms can be established, the power of vested interests in opposing change, the functioning of the labor market and the degree of competitiveness in domestic product markets. Stern (1991) has identified a number of other factors that are potentially important, notably managerial competence and the quality of infrastructrures including features of the social infrastructure such as honesty, benevolence of bureaucracy, and how clearly property rights are defined.

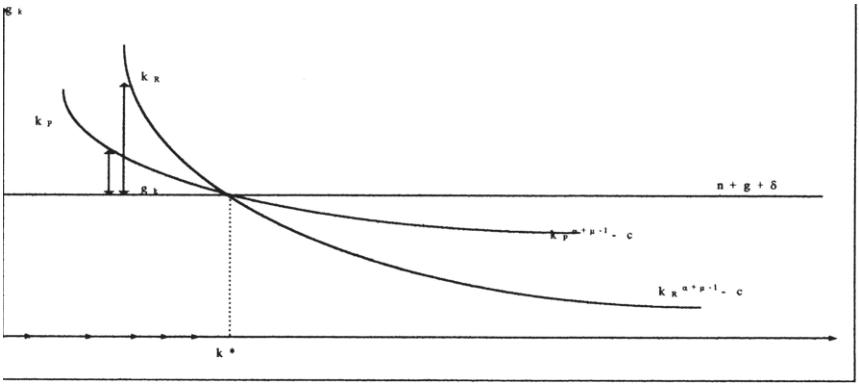
In sum, two implications of these ideas emerge [Baumol et.al., 1989]: first, it means that those countries that lag somewhat behind the leaders, once they have reached a particular threshold level of development, can be expected systematically to move toward the level of achievement of the leaders. Second, the mechanism undermines itself automatically as follower contries gradually eliminate the difference between their own performance and that of the countries that were ahead of them.

4.2.2. The neoclassical approach

Neoclassical growth models have profoundly affected the way in which macroeconomists think of long-run interrelationships between economies. These models predict, based on the assumptions of decreasing returns to capital and free access by all countries to a common technology, on the one hand, that growth cannot be sustained permanently and, on the other hand, that countries converge to a steady state [De la Fuente, 1995a]. In the absence of technical progress,

decreasing returns imply that the marginal product of capital will fall with the accumulated capital stock, reducing both the incentive to save and the contribution of a given volume of investment to output growth. The same mechanism explains the convergence prediction: poorer countries will have a greater incentive to save and a higher rate of growth for a given rate of investment. It follows that if we have two identical economies in all respects, except of their initial capital stocks, the one with the lower capital stock will grow faster until the steady state output per capita levels of both countries have been equalized.

Figure 4.1. : Absolute convergence



Source: Sala-i-Martin (1990).

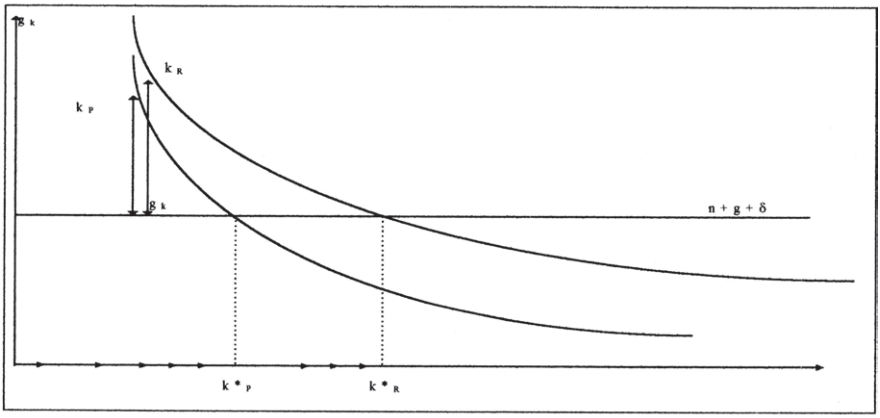
This prediction will be reinforced by open-economy considerations, as labor flows and trade will both contribute to factor price equalization. Introducing technical progress does not change the qualitative results of the neoclassical model as long as one assumes that technology remains a public good such that economies do have access to common technical knowledge in the long-run[3].

Suppose two countries that are characterized by equal consumption ratios, technology levels, labor force growth rates and capital depreciation rates [see Figure 1]. Both countries are at a lower income level than in the steady state and will therefore experience a period of economic growth. Country P is poor and country R is rich, which means that the capital intensity and productivity are higher in the rich country than in the poor one, $k_R > k_P$. Since the return of an additional unit of capital is negatively related to the stock of capital, the marginal

productivity of capital is higher in the poor country. This means that the capital intensity and production per capita grow faster there. This has been described as *absolute convergence* [Sala-i-Martin, 1990].

If the countries also differ in some other aspect, they will not move towards the same steady state [see Figure 2]. Assume, for example, that the poor country has a lower savings ratio, so that the steady state capital stock per capita is less in the poor country than it is in the rich country. In this example it is assumed that the rich country grows faster than the poor one so there is no convergence in the absolute sense. In contrast, each country is converging with a decreasing rate of growth in capital intensity and production per capita towards its own steady state, which means that the steady state production per capita, y_i^*, varies between countries. This has been described as *conditional convergence* [Sala-i-Martin, 1990; Mankiw et.al. 1992].

Figure 4.2. : Conditional convergence



Source: Sala-i-Martin (1990).

4.2.3. Endogenous growth

An important motivation for research on endogenous growth, noted by both Romer (1986) and Lucas (1988), is the apparent failure of traditional models to explain the persistence of income differences across countries[4]. In these models, because of an assumed increasing marginal productivity of knowledge, both the growth rates and the per capita income level depend on the economy's initial

physical and/or human capital endowments, thus on history. The existence of a region of capital values over which the production function is convex leads to different long-run steady states for different initial conditions. Whereas early models are based on economies of scale as a mechanical instrument to obtain endogenous growth, Romer (1990) develops a model that relies on a combination of economies of scale and imperfect competition in which technological change arises when self-interested people have the opportunity to benefit from a monopoly rent. Technology is a non-rival input which is only partially excludable; its use by one firm explains knowledge spillovers and denies a constant returns to scale production function, since it is not necessary to replicate the non-rival inputs. The decentralized equilibrium is sub-optimal because of maximization of entrepreneurial benefits, which involve elements of imperfect competition. These endogenous growth models suggest, firstly, that social returns on R&D or education are larger than private returns. Thus, in the absence of a planner that closes the gap between social and private returns, a competitive equilibrium implies a sub-optimal accumulation of human capital and suggests a possible role for governments in subsidizing research, being effective in influencing the rate of growth of an economy in the long-run. Public intervention may thus in principle be used to coordinate domestic and international policies. Secondly, permanent differences in growth rates may arise as a result of differences across countries in economic policies, market size, or factor endowments. Thirdly, the existence of multiple long-run equilibria in the sense that the economies converge to different steady states (i.e. even for similar savings and population growth rates). The difference between these predictions and those of older models is not that significant, as has been emphasized by De la Fuente (1995b). In particular, neoclassical models suggest that income differences across countries will tend to disappear only under the assumption of identical economies except of the initial capital-labor ratio. In Solow's (1956) model, for example, long-run income levels are a function of investment rates and the rate of population growth, and may, therefore, differ across economies. Similarly, Abramovitz (1986) emphasizes social capability as condition for convergence. As has been emphasized by Barro and Sala-i-Martin (1992) and Mankiw et. al. (1992), and has been shown graphically before, traditional models only suggest convergence conditional on factors like investment rates, population growth rates or social capability, and are in this sense compatible with high and even rising international inequality. The lack of fundamental difference in their predictions makes it, however, difficult, if not impossible, to discriminate between the theories based on convergence.

In essence, the predictions of theoretical models concerning the prospects for income convergence across countries depend crucially on two assumptions [De la Fuente, 1995b]: the existence, or non-existence, of increasing returns to reproducible factors, including the stock of technological knowledge, and the degree to which useful knowledge is a public good across countries.

4.3. Convergence concepts

In this section, alternative convergence concepts are reviewed. First, I concentrate of formal, mathematical definitions of convergence and turn thereafter to empirical convergence concepts applied in the literature.

4.3.1. Definitions of convergence

Intuitively, convergence is given when the difference between two or more time series is reduced over time, or, more formally, becomes arbitrarily small as time elapses. For random series, such as most of economic variables, this can be extended by introducing the concept of stochastic convergence, according to which the expected value of the difference of two or more series should be constant, or, more strongly, zero [Bernard, 1991; Hall et.al, 1992]. Formally, we can express this by the relation:

$$E_t\{\lim_{t\to\infty}(X_t - \Psi Y_t)\} = \alpha \tag{4.1}$$

where X_t and Y_t are arbitrary time series. The probability that the two series differ by a specified amount α is required to become arbitrarily small. However, if nonstationary time series are present, a drawback of this definition is that the two series may still behave quite differently even after convergence. An alternative, more restrictive definition of convergence is stated in terms of probability limits [Hall et.al., 1993]:

$$p\lim_{t\to\infty}(X_t - \Psi Y_t) = \alpha \tag{4.2}$$

Two sufficient, but not necessary, conditions for this are

$$\lim_{t\to\infty} E(X_t - \Psi Y_t) = 0 \tag{4.3a}$$

and

(4.3b) $\lim_{t \to \infty} Var(X_t - \Psi Y_t) = 0$

This definition restricts asymptotically the ability of the series to move away from each other. Another definition that is sometimes appropriate, and on which some empirical work is focused, is conditional convergence. This would be useful as a predictive tool, i.e. when seeking an answer to the question whether, given existing information, future convergence is likely. The modified definition of convergence in probability is

(4.4a) $\lim_{t \to \infty} E(X_{t+s} - \Psi Y_{t+s} - \alpha | \Omega_t) = 0$

and

(4.4b) $\lim_{t \to \infty} Var(X_{t+s} - \Psi Y_{t+s} - \alpha | \Omega_t) = 0$

where Ω_t is the information set available at time t. Thus, most importantly, the formal definitions of convergence relate to the long-term reduction of differences of economic variables. In addition, they take into account of the randomness of time series.

4.3.2. Empirical concepts of convergence

The convergence hypothesis has recently been subject of growing research interest and has led to the development of a number of different empirical concepts. Several empirical concepts of convergence have received special attention recently[5]. One concept, referred to as *σ-convergence* by Barro and Sala-i-Martin (1991, 1992), considers the cross-sectional dispersion in per capita earnings. σ-convergence occurs if the cross-sectional dispersion in per capita earnings, typically measured by either the standard deviation or the coefficient of variation, declines through time. It is, however, only a crude measure of dispersion, since the estimated variance of income across countries is influenced by shocks hitting the economy at any particular point in time. Hence, even if the economies were truly getting closer in the long-run, this statistic would have a lower bound by the variance of these shocks [Andrés et.al.1995].

Another concept, used among others by Baumol (1986), DeLong (1988), Barro (1991) and Dowrick and Nguyen (1989), and referred to as *absolute β-*

convergence by Sala-i-Martin (1990), occurs when poor countries tend to grow faster than rich ones, such that poor countries catch up to rich ones in terms of the level of per capita output through time. The concept is generally implemented through a regression of the form

$$(4.5) \qquad \Delta y_t = \alpha + \beta y_0 + \nu_t$$

where Δy_t refers to an average growth rate. A negative coefficient of the initial level of per capita output is equated with convergence. In the long-run, expected per capita income is the same for all economies in the group, independently of its initial value. While this does not mean that inequality will disappear completely, for there will be random shocks with uneven effects on the different economies, such disturbances will only have transitory effects, implying that, in the long-run, we should observe a distribution in which the relative positions of the different countries change rapidly. Barro (1991), Barro and Sala-i-Martin (1992), and Mankiw et.al. (1992) emphasized, as noted before, that the neoclassical growth model implies only convergence after it has been controlled for differences in the economy's steady-states. They have called this concept *conditional convergence*, which is implemented through a regression of the form

$$(4.6) \qquad \Delta y_t = \alpha + \beta y_0 + \pi_i X_{it} + \nu_t$$

where the x_i refer to country-specific determinants of the steady state income per capita. Though the implementation of conditional convergence is similar to absolute β-convergence, its interpretation is fundamentally different. With conditional convergence, each country (may) converge to its own steady state, which could be very different from each other. Hence, a high degree of inequality among economies could persist, even in the long-run, and one could observe high persistence in the relative positions of the different economies. In other words, with conditional convergence, rich countries will tend to remain rich, and the poor will continue to lag behind.

The fourth concept is referred to as *stochastic convergence* [Carlino and Mills, 1993]. This line of empirical research, employed by Bernard (1991), Bernard and Durlauf (1995), and Jones (1995), relies on the time series properties of output series. Cross-country growth behavior is studied in the sense that convergence means that all per capita output discrepancies are transitory. Output in each country is realized to be subject to stochastic shocks, like technological or monetary disturbances, which render the level of output per

capita in each country nonstationary. Intuitively, cointegration is given if the shocks affecting the individual countries have a common stochastic component, so that the relative output series, $y_{it} - y_{jt}$, is stationary. In addition, economic convergence requires that the difference between output in country i and country j, $y_{it} - y_{jt}$, becomes smaller over time. Formally, cointegration concepts assume that the level of output per capita in each economy i is integrated of order one, thus, its growth rate follows a stationary stochastic process. Economic convergence, in this interpretation, then implies that output differences between countries i and j, $y_{it}-y_{jt}$, obey a zero mean stationary stochastic process.

Recently, a method based on *income distribution dynamics* has become increasingly popular in empirical research. As argued by Quah (1993 a,b), analyzing an average or representative economy in a cross-section of economies may give a misleading picture for the behavior of that entire cross-section. The economic basis of the concept is that economies in an integrated world tend to be increasingly interdependent units, which would make it necessary to drop the neoclassical "representative economy" assumption [Quah, 1994b]. Therefore, he proposes to study the probability distribution of transition over time. The concept, in its discrete form, involves categorizing the sample of countries into income classes and developing the law of motion for the probability distribution of being in income class i at time t+k conditional on being in income class j at time t. Convergence can then be found in two ways: on the one hand, convergence is given when the steady state probability distribution has a unimodal shape. That is, intuitively, the probability for a country i in the distribution of ending up, in the long-run, at the mean income value should tend to one. To calculate the long-run probability distribution requires that the conditional probability is time invariant. Alternatively, by fixing the probability vectors to be uniform and identical for every point in time, one can define a time-variant grid (quantiles) and associated to that a sequence of fraction transition probability matrices. The change in the grid describes the evolution of the cross-section distribution for one period to the next one. Convergence is taking place when the sequence of quantiles degenerates to the mean value of the distribution [Andrés and Lamo, 1994].

4.4. Review of the empirical literature

In this section I discuss the empirical literature on growth and convergence[6]. I will focus on a review without a critical evaluation, as it is the purpose of this section to give an impression of the results obtained from similar analyses as the

subsequent one in the following sections. The section is structured based on the alternative empirical concepts of convergence discussed before. In sub-section one, I discuss some of the main contributions being motivated by the catching-up hypothesis. In sub-section two, empirical work using the concept of conditional convergence is reviewed. Sub-section three then contains empirical work on stochastic convergence, while sub-section four is related to empirical work on income distribution dynamics. In sub-section five I focus explicitly on empirical work using data from the EU.

4.4.1. Catching up and falling behind

The original empirical work on economic convergence is concerned about a negative relation between the average growth rate and its initial level and, thus, with unconditional convergence. Productivity growth rates are expected to be inversely related to their initial levels for three reasons: first, learning and imitating an existing technology should be easier than inventing and testing a new one. Second, countries with lower levels of industrialization may have greater returns relative to the most advanced economies in training labor and then reallocating it between agriculture and industry. Third, countries with lower levels of industrialization might have greater opportunities to exploit the possibilities of advanced scale-dependent technologies. An inverse relation between productivity growth rates and their initial levels is consistent with the neoclassical growth model, once you assume that all economies in the sample are structurally identical and differ only in their initial capital-labor ratios.

Abramovitz (1986) and Baumol (1986), using data compiled in Maddison (1982), support the convergence hypothesis for a set of sixteen presently industrialized countries over the time period 1870 - 1979. Abramovitz uses rank correlation coefficients and finds an inverse correlation between average productivity growth rates and their initial level, which confirms the potential to catch up for technologically backward countries. In addition, he finds that the estimated coefficient is higher, the longer the length of the sub-period under study, suggesting that the higher a country's productivity level in 1870, the more slowly that level grows in the following century. Baumol performs a regression of the average productivity growth rate and the initial level and obtains the following results:

$$\Delta \ln y_t = 5.25 - 0.75 \ln y_{1870} \qquad R^2 = 0.88$$

He obtains a coefficient of determination, R^2, of 0.88, thus indicating that 88% of average growth is explained by the initial level. De Long (1988) criticizes the findings of Baumol on grounds of his results suffering from both sample selection bias and measurement error. That is to say, De Long argues that the results of Baumol do not provide conclusive information on convergence, because all countries are presently industrialized economies which have successfully performed during the 20th century. He argues that only a regression run on an ex-ante sample, a sample not of nations that have converged but of nations that seemed likely to converge, could tell whether growth since 1870 exhibits convergence. Based on this kind of reasoning, he then constructs and analyzes an alternative sample, excluding Japan and adding data for Argentina, Chile, East Germany, Ireland, New Zealand, Portugal and Spain, which represents more accurately a sample of ex-ante probable "winners". De Long performs a similar regression as Baumol, allowing, however, for measurement errors, and rejects convergence in the central case, when the variance of the unobservable measurement error equals the error term in the regression. He concludes that evidence in favor of convergence is no greater than evidence against it. Baumol and Wolff (1988), in reply to the comment by De Long, contribute to the discussion by examining additional data sets and by using additional methods for analyzing convergence. Firstly, the authors use a data set of 19 European countries over the period 1830 - 1919. The authors rank the countries in descending order of GNP per capita in 1870, successively construct samples consisting of the top 8, top 9, top 10,..., top 14 countries, and plot the corresponding time-series of the coefficients of variation. They find that only the top-8-country-sample support the convergence hypothesis, whereas all the other groups consisting of larger samples display a widening of income dispersion over time, thus indicating economic divergence. Secondly, Baumol and Wolff analyze post-World War II growth performance for 72 countries. Applying a similar ranking procedure as before, they find that per capita incomes among ex ante selected LDC's had diverged while the opposite had been true among initially industrialized countries. They supplement and confirm these initial results by formal nonlinear and piecewise linear regressions and conclude that there is evidence in favor of "convergence clubs". The richest 15 countries are described unambiguously by economic convergence, a result that holds also for larger sets of countries, once LDC's are excluded. However, for larger samples including LDC's cross-country differences are persistent, with little indication for convergence[7]. Dowrick and Nguyen (1989), using the data set by Summers and Heston (1988), extensively tested the convergence hypothesis among 24 OECD

countries in the post-World War II period. First, coefficients of variation and standard deviations of log output are calculated, supporting the convergence hypothesis as they both decline continuously from 1950 to 1985. Nonparametric tests show that the poorer half of the sample has grown faster than the richer over the entire period and over three sub periods (1950-60, 1960-1973,1973-1985). Second, a regression analysis of average growth rates of output per capita on the initial real GDP per capita is performed, indicating a negative sign of the coefficient and reaching an R^2 of over 0.50. As in previous papers, the negative sign is interpreted as support for the convergence hypothesis, since countries with initially lower incomes tend to grow faster than initially rich countries. Dowrick and Gemmel (1991) extend the previous analysis to include 78 countries across the world. They analyze four alternative explanations for the existence of convergence clubs within a growth-accounting framework: technological spillovers, intersectoral disequilibrium in factor markets, sectoral differences in technical progress, and capital deepening. They find that, whereas agricultural productivity levels of poor countries relative to rich countries are catching-up, industrial productivity levels are diverging both within a group of poor countries and relative to the group of rich countries[8]. The authors conclude that, for the industrial productivity sector, technological spillovers assist productivity growth in countries at a medium level of development, but are unavailable to the least developed countries. They interpret their results as being indicative for a structural proverty threshold in world development. Hansson and Henrekson (1994a,b) analyze technological catch-up within a disaggregated study for 14 OECD countries. They derive a testable model and find that after 1970 there is no catching up effect in the tradables sector, while catching up is found for industries in the nontradables sector.

These papers do not provide an unambiguous picture as to whether the world is described by economic convergence or divergence. However, they suggest three things: first, among the richest countries, a catch-up process is to be observed. Second, the world's poorest countries do not seem to catch up. Relative differences to the rich economies do persist, or possibly, they even increase over time. And third, they suggest what Baumol et.al.(1989) call "convergence clubs", that is, within a specific group of countries convergence is to be observed, whereas across groups income differences do persist.

4.4.2. Conditional convergence

As is the catching-up literature, the empirical work on conditional convergence is concerned with the relation between the average growth rate and its initial income. However, the interpretation is strikingly different. Whereas the literature on catching-up expects an inverse relation between the average growth rate and its initial level, because of factors like imitation and learning, returns from training, or opportunities of exploiting scale economies for backward countries, within the neoclassical framework, initial income per capita provides a measure of how far removed each country is from its specific steady state value.

The origin of the empirical literature on conditional convergence is the work by Romer (1987a). He uses a conditional convergence regression of the form as in (8) with the investment rate as conditioning variable. His results are presented in Table 1.

Romer finds a negative coefficient of initial income. There are two additional striking aspects of his results: first, he obtains a positive effect of the investment rate on the average growth rate in all regressions. Second, the capital's share coefficients are very high. In the third regression the capital share is estimated to be 74%.

Table 4.1: Conditional convergence regression

	a	α_1	b	α_2	c	σ	Log Likelihood
I	-.27	.51	12.0	.77	.01	1.5	538.6
II	-.24	.51	11.5	.77		1.5	538.5
III	.35	.74	10.2			1,5	537.7

Source: Romer (1987a) [Table 4]

This stands in contrast to the predictions of the neoclassical growth model, according to which the estimate of a should be on the order of 0.25 to 0.33. These results have received special attention [Romer, 1994]. On the one hand, they indicate that the capital's factor share is higher than previously perceived to be and that diminishing returns to capital are setting in more slowly than previous estimates suggested. On the other hand, they may be interpreted in a way that convergence would have taken place if the investment rate had been held constant, or, more generally, if other variables had been held constant. Barro (1991) extends this latter line of reasoning, analyzing average growth rates for a set of 98 countries in the period 1960 - 1985. He tests whether the average

growth rate across economies is inversely related to the initial level of per capita GDP, which he interprets, as usual, as indicator for economic convergence. At first, without additional explanatory variables he finds no significant relationship between the initial level of GDP per capita and its average growth rate. However, as in the work by Romer, Barro obtains an inverse relationship by adding additional explanatory variables in the regression. First, he adds school-enrollment observed at the beginning of the period, as a proxy for human capital, then he adds fertility and investment and obtains, in each case, an inverse relation between the average growth rate and its initial level.

Table 4.2.: Estimated rates of convergence. Regions in a country

Author	Sample	Rate of convergence (in % p.a.)	Additional Variables
Barro and Sala-i-Martin (1993)	47 Japanese prefectures 1930 - 1987	2.3	- regional dummies
Barro and Sala-i-Martin (1992)	48 U.S. States 1880 - 1988	1.8	- regional dummies
Coulombe and Lee (1993)	10 Provinces in Canada 1960 - 1991	1.05	no
Coulombe and Lee (1994)	10 Provinces in Canada 1968 - 1992	1.26	no
Dolado et.al. (1995)	50 regions in Spain 1955 - 1989	1.81	yes - savings rate
Di Liberto (1994)	20 regions in Italy 1960 - 1991	7.47	- enrollment rate - public investment
Herz and Röger (1995)	75 regions in West Germany 1955 - 1988	4.4	- schooling - regional dummies
Holtz-Eakin (1992)	48 U.S. States 1973 - 86	1.91	- state endowment variables
Keller (1995)	26 regions in Germany (East and West) 1955 - 1988	2.11	- fixed effects

Source: Own compilation.

Mankiw et. al. (1992) construct a human capital augmented version of the Solow model and test for convergence, using data for 98 countries over 1960 - 1985. Unconditional convergence, i.e. without conditioning on determinants of the steady state, is rejected. Then, by conditioning for the rates of investment or alternatively of saving, population growth and human capital, a significant

inverse relation between the average growth rate and the initial level - conditional convergence - is found. In contrast to other similar studies, however, the conditioning variables are derived from their augmented Solow-model. Barro and Sala-i-Martin (1992) analyze convergence across 48 U.S. States using both personal income data for the period 1840 - 1988 and gross state product data between 1963 and 1988. The authors use a regression of a form like equation (4), which they derive from a neoclassical growth model and which is estimated using nonlinear least squares. Initally, additional explanatory variables are excluded, so that the regression is an estimation of the average growth rate of the 48 states on their initial average level in 1840. They estimate the equation over sub-periods and over the whole period and obtain, in general, a significant inverse relation, thus convergence. However, tests for parameter stability of β indicate unstable coefficients, which lead the authors to include an additional explanatory variable, viz. a sectoral decomposition variable.

Table 4.3: Estimated rates of convergence. Multi-country analyses

Author	Sample	Rate of convergence (in % p.a.)	Additional Variables
Barro (1991)	98 countries 1960 - 1985	1.84	- enrollment rate - fertility rate - investment rate
Islam (1995)	96 countries 1960 - 1985	3.75	- investment rate - enrollment rate - fixed effects
Knight et.al. (1993)	98 countries 1960 - 1985	3.91	- investment rate - enrollment rate - fixed effects
Mankiw et. al. (1992)	98 countries 1960 - 1985	1.37	- investment rate - enrollment rate
Sala-i-Martin (1995)	110 countries 1960 - 1990	1.3	- enrollment rates - savings rate - political variables
Wolf (1994)	98 countries 1960 - 1985	0.9	-investment rate - labor growth rate - mortality - revolutions & coups - continent dummies

Source: Own compilation.

The authors argue that the unstable pattern of the β coefficients across subperiods reflect aggregate disturbances that have differential effects on state incomes. Adding the sectoral decomposition variable, they are indeed able to accept the hypothesis of parameter stability across sub-periods. The authors obtain a coefficient β = - 2.49% for the period 1840 - 1988 which suggests that the time needed to eliminate half of an initial gap between the states is about 35 years. Barro and Sala-i-Martin (1993) apply a similar framework to Japanese prefectures and obtain similar rates of convergence.

Subsequently, conditional convergence regressions have been applied by several authors for different data sets. Table 4.2. summarizes recent estimates of the convergence coefficient obtained by various other studies using data from regions within one country. Table 4.3. summarizes estimates using data from multi-country regressions. In these tables papers published after 1991 are summarized[9]. In general, conditional convergence is found by empirical studies. Convergence rates for regions within a single country tend to be slightly higher, due probably to increased factor mobility on regional levels, than those obtained in cross-country studies.

4.4.3. Stochastic and local convergence

One way to interpret the implications of endogenous growth theories is in terms of multiple equilibria. Indeed, even if a set of control variables, meant to control for microeconomic heterogeneity, seems to support the convergence hypothesis, this may be in line with the existence of stable multiple equilibria in long-run output per capita. That is to say, differences in aggregate production functions and, correspondingly, technology may lead economies to converge to different steady states in output per capita. Durlauf and Johnson (1992) labeled this "local convergence", which, as they show, is consistent with several theories of endogenous growth and which stands in contrast to Solow-kind "global convergence", where all countries converge to the same steady state. They test the local convergence proposition for 98 countries over 1960 - 1985, the same data set that had been used by Mankiw et.al. (1992). First, based on the same convergence equation as in Mankiw et.al (1992), the authors use misspecification tests to test the hypothesis that the data can be described by a single production technology. They split the data set ad hoc into sub-groups, taking literacy rates and initial income levels as splitting criteria, and reject the null hypothesis of equal production technologies, which indicates local convergence. In a second step, the authors use regression trees, a nonparametric method, to split the overall

sample endogenously into sub-groups. They test for differences in technology and find evidence in favor of the local convergence proposition. In addition, the authors find that the speed of convergence in the sub-samples is faster than in the overall sample. They interpret their results as being in favor of Baumol's (1986) convergence clubs. Andrés and Boscá (1993) subsequently test the local convergence proposition for 24 OECD countries, using data from the OECD National Accounts for the period 1960 - 1991. The authors use an alternative sample-splitting method, which is directed towards revealing differences in initial conditions. They test sequentially, removing a priori reasonable countries at a time, for significant individual differences in the initial level of technology. They obtain three technological levels, which they label lagged, intermediate, and leading. They find that the rate of convergence in the sub-samples is greater than in the overall sample, with the rate of convergence among advanced economies being twice as large as that among the backwards ones. Tests for common technology point to the presence of two different technologies inside the OECD, thus confirming the local convergence proposition. Ben-David (1993, 1994, 1995) uses an alternative framework in his paper. He analyzes how the empirical convergence results change, on the one hand, with variations in the convergence group membership i.e. the relative wealth of the countries in the group and, on the other hand, with variations in the convergence group size. He analyzes data by Summers and Heston (1988) for 113 market economies between 1960 and 1985. Ben-David tests for convergence by pooling each country's annual discrepancy from the group average and estimating the following equation:

$$(4.7) \qquad (y_{i,t} - y_t) = \phi\,(y_{i,t-1} - y_{t-1})$$

where y_{it} is country i's GDP per capita at time t and y_t is the group average at time t. The author interprets ϕ as an indicator for economic convergence. A value of ϕ below 1 is supposed to indicate convergence and a value greater than 1 economic divergence. He ranks the countries with respect to income per capita, divides the total sample into different groups, with the number of groups ranging between 1 and 8, and runs equation (7) for each group. He finds that the wealthiest countries converge upwards and poorest countries downwards, thus that rich countries are getting richer and poor countries poorer. He shows that this result is robust for variations in group size and for other partitions of the world. Bernard and Durlauf (1995) test convergence in a stochastic growth framework, using data from 15 industrialized countries over the period 1900 to 1987[10]. The authors apply cointegration concepts, i.e. convergence requires that

the permanent components of output per capita are the same across countries. The authors tend to accept the hypothesis of no convergence. They conclude that per capita output differences appear to persist over time. Carlino and Mills (1993) study convergence of per capita income and per capita earnings in the regions of the U.S for the period 1929 - 1990, applying the stochastic convergence concept. After allowing for a break in 1946, they find evidence in favor of the neoclassical model's prediction of convergence. They find that shocks to per capita earnings are more persistent than shocks to per capita income, which leads the authors to conclude that the regional distribution of transfer payments tends to smooth the effects of deviations on relative regional per capita earnings and to reinforce trends in per capita income convergence. Crafts and Mills (1995) analyze stochastic growth in output per capita in 17 OECD countries from the late nineteenth century to 1989. They find that output per capita behavior in all countries is subject to structural breaks. The period 1951 to 1973 is argued to be an epoch of exceptionally rapid economic growth in Western Europe, due to catch-up and reconstruction.

4.4.4. Income distribution dynamics

Quah (1993 a,b) is directed towards focusing on the long-run distribution of incomes over time. The author analyzes the distribution of incomes across countries, using the Summers and Heston (1988) data set for 115 market economies. Quah discretizes the set of possible values of income relative to the world average at time t into intervals at ¼ , ½ , 1, and 2 and estimates the probability that an economy at time t in one of these intervals remains or transits to another state. For the 23-year transition from 1962 to 1985, he obtains a probability of the richest countries to remain richest of 95%. In contrast, the probability of the poorest countries to remain poorest is 76%, both entries being by far the greatest in the transition matrix. His results suggest economic divergence, the world becomes partitioned into rich countries, whose share in total world income increase, and poor countries, whose share decrease further. Desdoigts (1994) extends the analysis of the world income distribution in various ways. First he confirms Quah's results of the distribution of income in the world becoming more unequal over time. He finds that, while the density estimate of income per capita and income per worker initially, in 1960, exhibits an unimodal structure, after 25 years, it exhibits a fourth or fifth modes structure. He interprets this evidence in terms of local convergence. In addition, applying non-parametric smoothing techniques, he analyzes the relation of income and various

variables of interest, viz. investment, public consumption, private consumption, and education. He finds that human capital accumulation functions as a main source of economic growth, in line with recent theoretical suggestions. The mean response of growth rates is strong for low investment shares, flattens, however, out among the highest shares of income devoted to investment. Quah (1994c) performs an analysis of the distribution of income for the US States, using data from 1948 - 1989. Here, intra-distributional mobility turns out to be high. Convergence is uniform towards a long-run distribution with only a single peak. Andrés and Lamo (1994) study cross-section growth dynamics of 24 OECD countries. Using raw data, i.e. income per capita relative to the mean value, they find polarization in the growth process. The results show a bimodal distribution of income per capita across OECD economies. In a second step, in order to make their analysis comparable to conventional parametric regressions, they examine the distributional dynamics of the residuals from a conditioning regression. The authors condition on accumulation rates of physical capital and population. At first, they impose a common technology restriction across countries on the conditioning regression. Most interestingly, and quite surprisingly, the estimated density functions of the residuals do still evolve into a bimodal distribution. There is little change in the results after conditioning on physical capital and population. The authors interpret these results as evidence against conditional convergence. The authors repeat the analysis, following Durlauf and Johnson (1992), by allowing for time-invariant and country-specific effects. Here the results show higher intra-distributional mobility; the estimated density function evolves into an uniform distribution. However, only after relaxing the main assumptions of conventional cross-section regressions, evidence in favor of convergence is found. This line of literature indicates not only that the distribution of income in the world becomes more unequal over time, but even within industrialized countries with similar economic structures income differences seem to persist. The results are in line with Baumol's suggestion of existing convergence clubs.

Overall, the empirical evidence with respect to the evolution of the world distribution of income, or, in other words, with respect to convergence in the world economy, is mixed. However, there exists a broad consensus in the more recent literature suggesting an absence of convergence to a single steady state [Ben-David, 1994]. The absence of convergence to a single steady state may be explained either in the neoclassical tradition in terms of conditional convergence, that is, the rate of growth falls as the economy approaches its own long-run level, or in terms of local convergence and multiple equilibria.

4.4.5. Growth and convergence across Europe

In this sub-section I review contributions made within the context of growth and convergence using data from the European Union. Barro and Sala-i-Martin (1991) analyze 73 regions of 7 European countries, using data from 1950 - 1985. They start from the basic regression of the average growth rate on its initial level, dividing the total time period into sub-periods, and testing for parameter stability. As parameter stability is rejected using the basic regression, they continue to include regional dummies. The authors interpret regional dummies as proxies for country specific steady state values and for countrywide effects in the error term. They proceed by adding shares of agriculture and industry in total employment and find that the average growth rate is inversely related to the initial level, indicating convergence, with the coefficient b being stable over all sub-periods. The value of β for all sub-periods is around 2% per year. Subsequently, the authors turn to the behavior of the standard deviation of log output per capita over time (σ-convergence). They find that the dispersion of income has declined continuously, falling from 28% in 1950 to 18% in 1985. Neven and Gouyette (1995) apply three methods to analyze economic convergence in a sample of up to142 European regions for the period 1975 - 1990. First, they analyze σ-convergence, the behavior of the standard deviation of log income per capita over time. They assess convergence for the total sample of regions and for sub-samples, namely North- and South-European regions. The results are weakly in favor of a reduction of income dispersion. Second, the authors turn to analyze unconditional and conditional convergence. They find that there is no evidence for convergence, when country effects are not controlled for. The authors proceed, following Barro and Sala-i-Martin (1991, 1992), by including a sectoral composition variable, which measures the extent to which output was distributed in the initial period in growing sectors, and human capital. Testing for parameter stability over sub-periods, the authors find that the process of convergence is not stable, and that it slows down in the later part of the 1980s. Third, they use a markov chains approach to analyze the distribution of income over time in Europe. They find evidence in favor of a limited poverty trap; poorest and richest countries do not seem to modify their relative standing over time. The authors conclude that southern regions seem to catch up in the early 1980s but stagnate thereafter, while northern regions first stagnate and then converge towards the steady state. Pagano (1995) analyzes convergence of member states of the EC using cross-country data for the period 1950 to 1988. Using a cross-section approach he finds that since 1950 there has been Total Factor Productivity (TFP)

catching-up. However, he finds that the process was far from being stable, as the rate of convergence reached its peak during the 1960's but dropped virtually to zero during the 1980's. He continued using the stochastic convergence framework and strongly rejects the hypothesis of convergence in this dynamic framework. Grahl and Simms (1994) analyze regional data of the EC for the period from 1960 to 1990. While they find evidence in favor of conditional and unconditional convergence for the whole period, they note that in the second half of the three decades, thus from 1975 to 1990, the convergence coefficients are always less than half their value for the period 1960 - 1975. Thus, the convergence process has slowed down in recent years. Thomas (1995) examines 12 countries and 166 regions of Europe over the period 1975 - 1991. First, following Barro and Sala-i-Martin (1991, 1992), he tests for unconditional and conditional convergence. The author finds both unconditional and conditional convergence both on country and regional level. Conditioning on country-dummies and club-dummies[11], for example, he obtains a rate of convergence of 2.5% on regional level for 1981 - 1991. Subsequently, the author looks at the behavior of coefficients of variation of output per capita over time, which confirms his convergence findings. The variation of output per capita both across countries and regions in Europe falls within the 80s. Armstrong (1995) tests for conditional convergence using data of 85 regions in 12 European countries (1950-1990). He finds that EU regions exhibit a clear pattern of convergence. The rate of convergence, however, has slowed down in the past 20 years. Whereas between 1950 and 1970 the rate of convergence is about 2%, being in line with the results by Barro and Sala-i-Martin (1991), for the period 1970 to 1990 a rate of convergence of only 1% per year is found. Button and Pentecoast (1995) analyze the impact of the membership in the Exchange Rate Mechanism (ERM) on convergence, using data from 51 regions in 9 countries. They find that membership assisted GDP convergence in the 1980's. Larch (1994) studies cross-section growth dynamics of 107 regions in 9 European countries over the period 1970 - 1990. He estimates transition probabilities, grouping the spectrum of relative output per capita levels into three and five states. In both cases, he finds that the probability to retain in the initial position is high. Whereas intra-distributional mobility is high for middle-income countries, both towards the upper and lower end of the distribution, the probability for high income countries to descent is relatively low. The author tests and finds that the transition behavior has changed in the 80s compared to the 70s. In the 70s the low output regions moved comparatively fast, attaining a better possibility to improve in relative output terms. The very rich regions, on the other hand, moved slowly maintaining

their position for an extended period of time. In the 1980s transitions occur less frequently, especially at the lower end of the distribution, leading to a higher degree of persistence. Higher persistence, however, implies that the position of the rich countries is enforced and that the poor countries tended to be stuck in their positions.

Table 4.4. summarizes regression results obtained for data for the European Union being based on the concept of conditional convergence.

Table 4.4.: Estimated rates of convergence. Regions in EU

Author	Sample	Rate of convergence (in % p.a.)	Additional Variables
Armstrong (1995)	85 regions in 12 countries 1980 - 1990	0.83	- country dummies - structural variable
Barro and Sala-i Martin (1991)	73 regions in 7 countries	1.78	-country dummies - structural variable
Button and Pentecoast (1995)	51 regions in 9 countries	1.7	- ERM dummy - structural variable - country dummies
Grahl and Simms (1994)	51 regions 1960 - 1990	2.52	- country dummies
Neven and Gouyette (1995)	108 regions 1975 - 1989	1.61	- country dummies
Pagano (1995)	12 countries in the EC 1950 - 1988	1.3	- investment rate - employment share
Thomas (1995)	166 regions in 12 countries 1981 - 1991	2.5	- country dummies - club dummies

Source: Own compilation.

As can be seen, the rates of convergence are within a similar range as with other data sets, although the speed is slightly higher than in multi-country regressions using world economic data. In sum, empirical studies for Europe tend to support the convergence hypothesis. At the same time, however, the existing evidence indicates that the convergence process has not been stable, neither across time nor across countries. In recent years, convergence seems to have slowed down and may have become reversed.

4.5. On stability of growth and convergence in the European Union

In this section, descriptive statistical methods are used to analyze the convergence process. The purpose of this analysis is to underline the argument that convergence has not been stable, neither across time nor across countries. In doing so, as for the controversy on the righ measure of convergence, a number of alternative concepts are applied. In order to compare the performance of both measures, income per capita and labor productivity are used. The main data source is the Penn World Table 5.6., an updated version of Summers and Heston (1991). Output per capita data [RGDPCH] and Investment rates [I] cover the period 1950 - 1992 while output per worker data cover the period 1950 to 1990. Data used as proxy for human capital accumulation comes from the World Tables and the World Development Report, various issues. Secondary and tertiary school enrollment rates are available for the period 1960 to 1991, in general with a five-year frequency. Azariadis and Drazen (1990) provide data on literacy rates and output-to-literacy ratios, which are their proxies for human capital accumulation, for 1940 and 1960. Data for 10 EU-countries are provided in their Table II[12]. Assuming that enrollment rates behave proportionally to output-to-literacy ratios, I constructed enrollment rates for 1950 and 1955 for those countries. For the remaining countries, the values assigned to the missing observations is the average of the values for adjacent years or, if this is not possible, that of the closest available year.

4.5.1. Stylized facts

In Table 5 basic information on growth rates in per capita (per worker) output is presented. The average growth rate of GDP per capita (per worker) between 1950 and 1990 was 3.18(3.16) for the European Union. The rate of growth has slowed down considerably in recent years. Whereas the average growth rate of GDP per capita (per worker) was 4,02 (4.29) during the period 1950 - 1973, it was only 2,06 (1.63) during the 1973 - 1990 period, thus being reduced by about 50%[13]. The steady economic growth in terms of GDP per capita (per worker) is based, on the one hand, on low population growth (0.57% p.a.) and, on the other one, on high investment rates. Interestingly, the average investment rate has remained basically unchanged in both sub-periods. Average growth has been far from homogeneous. Differences in accumulation rates explain part but not the whole of the heterogeneity in average growth. Some countries' relative success can be explained by relatively high savings rates; this

Table 4.5 : Stylized facts on growth and convergence in the European Union

	GDP per capita (GDPpc) and GDP per worker (GDPpw)							Investment rate			School enrollment rates		Gov. Size
	1950 - 1990			1950-1973		1973 - 1990							
	GDP pc	GDP pw	Population	GDP pc	GDPpw	GDP pc	GDP pw	1950-1990	1950-1973	1973-1990	Second.	Tertiary	G/Y
Austria	3,67	3,79	0,27	4,72	5,40	2,24	1,61	25,90	23,45	25,76	66,78	18,12	15,19
Belgium	2,73	2,66	0,36	3,31	3,56	1,96	1,45	22,50	24,05	22,39	74,31	20,04	11,62
Denmark	2,43	2,09	0,46	3,05	2,96	1,59	0,91	24,20	25,18	23,85	79,32	21,48	18,43
Finland	3,47	3,41	0,55	4,24	4,39	2,43	2,07	33,32	35,23	33,22	84,78	21,54	13,86
France	3,09	3,10	0,77	4,07	4,38	1,76	1,38	26,77	25,50	26,56	67,89	21,11	15,85
Germany	3,58	3,48	0,59	4,80	5,14	1,94	1,23	25,86	30,16	25,58	59,08	19,12	15,22
Greece	3,92	4,09	0,73	5,68	5,93	1,54	1,60	23,61	22,32	23,21	60,72	12,94	13,01
Italy	3,06	3,34	0,41	3,12	3,71	2,97	2,85	25,68	21,37	25,53	65,05	17,00	14,67
Ireland	3,79	3,97	0,52	4,80	5,30	2,42	2,18	25,53	30,23	25,36	53,50	18,81	13,19
Luxembourg	2,28	2,46	0,64	2,35	3,03	2,19	1,69	26,86	36,37	26,52	50,11	...	10,04
Netherlands	2,64	2,52	0,98	3,47	3,78	1,52	0,80	22,57	25,95	22,33	72,85	23,34	14,03
Portugal	4,56	4,34	0,40	5,68	5,73	3,04	2,46	22,17	21,40	21,83	46,44	9,94	14,94
Spain	4,03	4,16	0,84	5,60	5,99	1,90	1,69	25,23	23,14	25,08	57,30	16,61	10,32
Sweden	2,33	1,91	0,50	2,92	2,57	1,54	1,00	22,12	23,75	21,98	69,35	22,91	20,05
UK	2,24	2,08	0,32	2,51	2,48	1,88	1,53	17,76	16,71	17,72	70,82	16,24	19,68
EU-15	3,18	3,16	0,57	4,02	4,29	2,06	1,63	25,26	26,11	25,07	65,22	18,51	14,67

Source: Own calculations.

is the case for Finland (3.47 and 33.32) among the fast growers and the United Kingdom (2.24 and 17.76) among the slow growers. Variations in enrollment rates are even sharper and at first glance its correlation with growth rates is less clear; Denmark, for example, with a very high enrollment rate has grown less than countries with much less human capital investment (Portugal or Italy).

4.5.2. The stability of relative output

Following Blanchard and Katz (1992), Ben-David (1994), and Neven and Gouyette (1995), I characterize the stochastic behavior of GDP per capita (per worker) in country i relative to the EU average.

Table 4.6.: Estimates of relative output per capita (per worker)

	Output per worker		Output per capita	
Coefficient	AR(1)	AR(2)	AR(1)	AR(2)
γ_1	0.974	1.199	0.978	1.201
γ_2		-0.218		-0.216
Unit root test[d)]	-7.549**[b)]	-5.4**	-6.603**	-7.3**
Impulse responses				
t = 1	1	1	1	1
2	0.974	1.199	0.978	1.201
3	0.948	1.221	0.958	1.225
4	0.924	1.202	0.937	1.211
5	0.900	1.176	0.918	1.190
10	0.789	1.041	0.824	1.077
20	0.607	0.815	0.666	0.882
30	0.467	0.639	0.538	0.722
60	0.213	0.307	0.283	0.396

a) * indicates significance at 5 per cent level; ** indicates significance at 1 per cent level. Critical values -2.12 and -3.19, respectively, taken from Quah (1994b) for (N,T) = (25,50)

b) * indicates significance at 5 per cent level; ** indicates signficance at 1 per cent level. Critical values -2.14 and -3.13, taken from Quah (1994b) for (N,T) = (25,25)

c) The regression results are based on the regressions:

AR(1): $y_t = \gamma_1 y_{t-1} + \varepsilon_t$

AR(2): $y_t = \gamma_1 y_{t-1} + \gamma_2 y_{t-2} + \varepsilon_t$

where y_t denotes GDP per capita (per worker) in country i relative to the EU average.

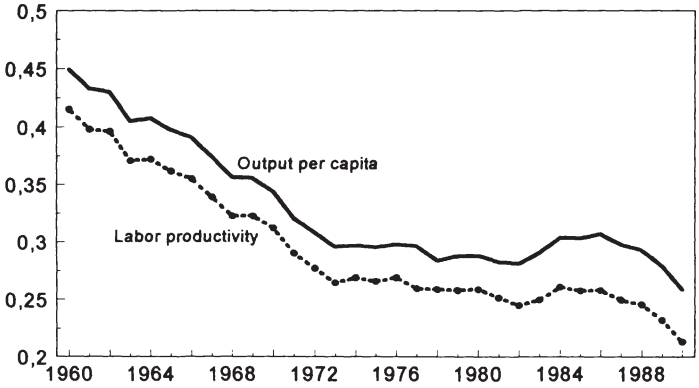
d) The unit-root test involves the null hypothesis that (γ_1 -1) equals zero. The values for (γ-1) are obtained from a regression in differenced form.

Source: Own calculations.

Pooling the data, I apply an autoregressive model and test for stationarity of relative output. The number of lags in the regressions is assumed to be either one or two. The results of the unit-root tests and the corresponding impulse response values are given in Table 6. The estimates suggest that relative output per capita (per worker) in the EU are characterized by mean reversion, so that they return to their mean after a shock, but they do so only at a slow rate. In the EU, relative output per worker is observed to adjust more quickly than output per capita. Whereas, after 30 years, 54 per cent of a shock to relative output per worker has been absorbed, the corresponding percentage of relative output per capita is only 47 %. These patterns can be compared to those observed in the US and in disaggregated regional data of Europe. Blanchard and Katz (1992) report that 43 per cent of the shock is absorbed after 10 years and about 80 per cent after 20 years. Neven and Gouyette (1995), analyzing 107 EC-Nuts II regions, find that after 30 years, only 25 per cent of a shock has been absorbed. Thus, whereas the process of mean reversion across European countries seems to be much slower than across regions of the United States, it is faster than on the regional level in Europe.

4.5.3. σ-convergence

Fig. 4.3.: Sigma-convergence of output per capita and labor productivity



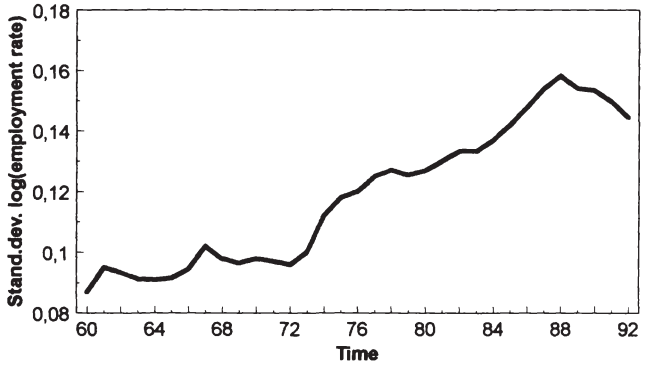
Source: Own calculations.

σ-convergence considers the cross-sectional dispersion in per capita earnings [Barro and Sala-i-Martin 1991, 1992].

σ-convergence occurs if the cross-sectional dispersion in per capita earnings, typically measured by either the standard deviation or the coefficient of variation, declines through time. The evolution of the standard deviation of (the log of) output per capita and productivity in the EU is displayed in Figure 3. σ-convergence in the EU in terms of output per capita has been less remarkable than in terms of labor productivity. This is due to relatively slower convergence in the demographic structure and in participation rates than in terms of employment. This point can be seen differently, and more clearly, by looking at employment rates.

The employment rate is defined as employment over population, hence its variance reflects the impact of both participation and unemployment rates. In Figure 4, the evolution over time of the employment rate in the EU is displayed. This statistic displays a smooth and rising trend until the beginning of the 1980's and a sharp increase thereafter.

Figure 4.4: Sigma-convergence of employment rate



Source: Own calculations.

This divergence in terms of the employment rate stands in contrast to the behavior of the dispersion of both output per capita and labor productivity.Figures 3 and 4 together indicate that productivity growth in Europe has converged over the post World-War II period, probably due to increased integration of goods and financial markets. However, the lagging countries have managed to close the gap with the more advanced ones in productivity terms only at the cost of low employment rates, thus output gains have been achieved with very low employment creation[14]. In Figure 5 σ-convergence of output per worker in the EU is displayed, this time together with the implicit σ-convergence that one would expect if the β-coefficient was stable along the sample period[15]. The implicit σ-convergence, which is derived by adding $\log(y_{it-1})$ on both sides of equation (4.5), computing the variance, and using the condition that the covariance between u_{it} and $\log(y_{it-1})$ is zero, is computed using the following difference equation[16]:

$$\sigma^2_t = e^{-2\beta}\sigma^2_{t-1} + \sigma^2_u \tag{4.8}$$

Assuming that the variance of the disturbance, σ^2_{ut}, is constant over time, ($\sigma^2_{ut} = \sigma^2_u$), which implies homoskedasticity of residuals, the solution of the difference equation (8) is given by

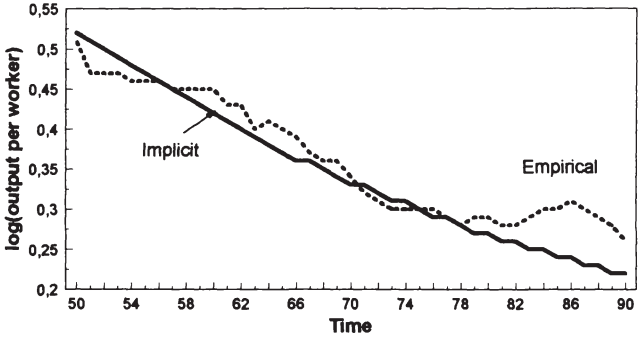
$$\sigma^2_t = \frac{\sigma^2_u}{1-e^{-2\beta}} + \left[\frac{\sigma^2_0 - \sigma^2_u}{1-e^{-2\beta}}\right]e^{-2\beta t} \tag{4.9}$$

Substituting the actual values of σ^2 in 1990 and 1950, σ^2_u is approximated by

$$\sigma^2_u = \left(\sigma^2_{90} - \sigma^2_{50}e^{-80\beta}\right)\left(1-e^{-2\beta}\right)\left(1-e^{-80\beta}\right)^{-1} \tag{4.10}$$

Empirical σ-convergence is less smooth than predicted by the theoretical concept of implicit σ-convergence. Since 1974, empirically, σ-convergence is above implicit σ-convergence, thus the theoretical σ-convergence permanently underpredicts income dispersion in the EU. Indeed, the figure suggests that convergence in the EU has virtually stopped in the mid 1970's and partly been reversed since then. Two explanations seem plausible: first, the variance of shocks affecting the economies might have increased, the economies thus having increasingly been subject to large asymmetric shocks. Second, the β-coefficient has not been stable all along the observation period.

Figure 4.5: Implicit and empirical sigma-convergence



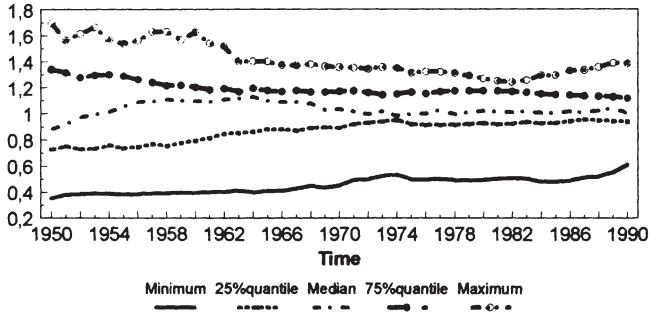
Source: Own calculations.

4.5.4. Income distribution dynamics

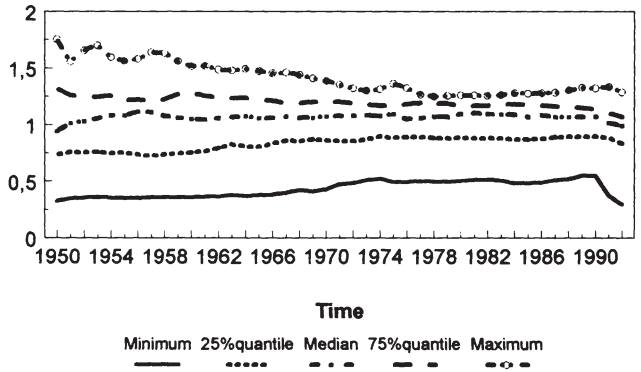
σ-convergence is, however, only a crude measure of dispersion, since the estimated variance of income across countries is influenced by shocks hitting the economy at any particular point in time. Hence, even if the economies were truly getting closer in the long-run, this statistic would have a lower bound by the variance of these shocks [Andrés et.al.,1995]. As argued by Quah (1993a,b), analyzing an average or representative economy in a cross-section of economies may give a misleading picture for the behavior of that entire cross-section. Therefore, he proposes to study the probability distribution of the evolution of income over time. We will make use of some descriptive techniques proposed by this author. The purpose is to obtain more detailed information as to which countries converge and which do not. We define the grid in such a way that the set of quantiles determines the sequence of cross-section distributions. The change in the grid describes the evolution of the cross-section distribution from one period to the next one. Convergence in this context is taking place if the

Figure 4.6. : Income distribution in the European Union

a) Fractiles GDP per worker



b) Fractiles GDP per capita



Source: Own calculations

Figure 4.7 :
a) Ranking of output per capita

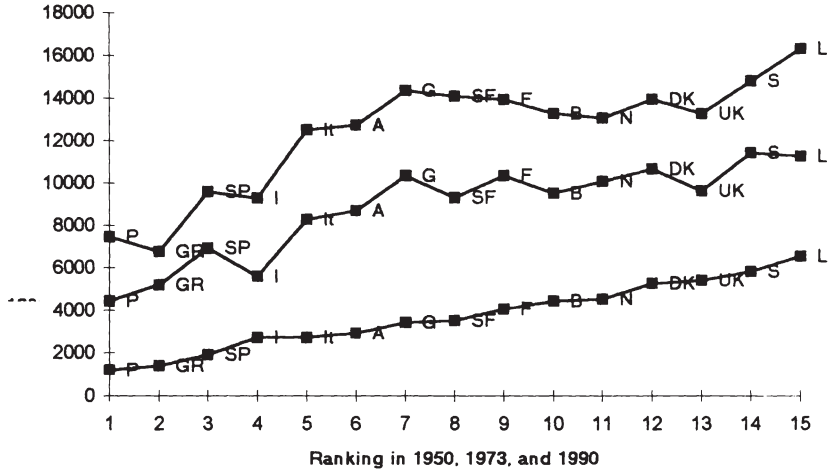
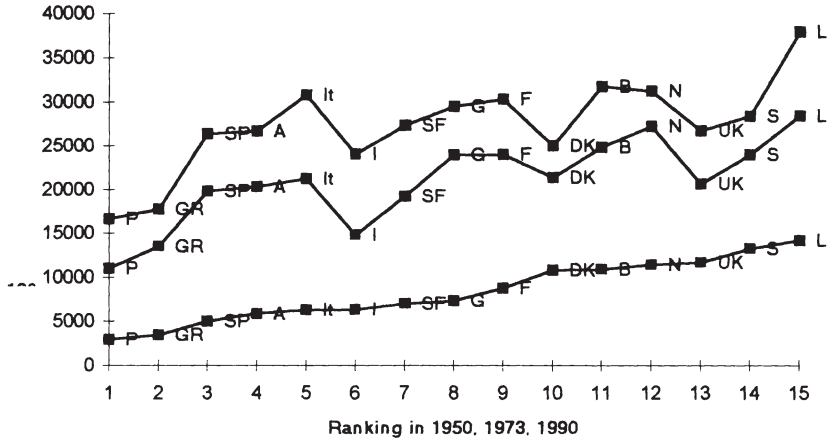


Fig. 4.7 :
b) Ranking of output per worker



Source: Own calculations.

sequence of quantiles degenerates to the mean. Figures 6 a) and b) show the sequence of fractiles of income per capita and labor productivity relative to the average value in the EU. The 25 per cent of countries with lowest productivity of labor in 1950 fell in a range of 0.35 to 0.72 of the EU average. The upper limit of this interval rose steadily until 1975 and has stayed around 0.95 times the average since then. The evolution of the lower limit was similar, so that the range remained about the same over the whole time period. The second and third quantile tend to concentrate around the mean. The 25 per cent of countries with highest productivity fell in a range of 1.33 to 1.69 of EU average. The lower limit evolved until 1.11, the upper limit until 1.38 times the average, where again it is to be noted that this is about the same as in the mid 70's. Indeed, the upper limit has been increasing slightly since the mid 70's. The behavior of income per capita over time is similar, though the degeneration process towards the mean is clearly less pronounced. As with labor productivity, since the mid 70's, the convergence process seems to be stagnating.

Figures 7 a) and b) provide additional information on the evolution of the income distribution in Europe. It ranks the countries according to the relative income per capita (labor productivity) in the first year of the sample and shows the evolution of the ranking over time[17]. Each line represents, for a single year (1950, 1973, 1990), the relative income of the EU countries ordered by their initial ranking. By construction, the larger the income differences, the steeper the lines are. Income per capita differentials among middle income countries and high-income countries have been reduced slightly over recent years, as the slope remains about the same. However, differences between, on the one hand, rich and middle income countries, and a group of poor economies on the other one, notably Portugal, Greece, Spain and Ireland, have widened over the post World-War II period, as the slope in this range becomes steeper over time. While the ranking of productivity evolves similarly, the changes in ranking are realized to be much more pronounced than changes in income per capita.

At this stage, I may review the main impressions obtained from the descriptive statistical analysis. First, the adjustment process of goods markets across regions in Europe is slower than across countries. This is in line with other empirical evidence concerning goods- or labor market-adjustment in the EU and implies that lagging economic regions in the EU have greater difficulties to cope with region-specific structural adjustment problems than countries with country-specifc ones. Second, economic convergence of output per worker in the EU over the post World-War II period is confirmed. Convergence is found by applying σ-convergence. The summed deviation from the mean across EU countries has

decreased over time. However, first, σ-convergence is seen to be empirically less smooth than theoretically predicted and, second, the process of convergence seems to have been reversed since 1974. Third, while income differentials have been reduced among middle- and high-income economies, differentials to a group of poor economies remain persistent. Thus, while on average European economies seem to converge, this process is far from common to all economies. The descriptive analysis in this section, thus, confirms the impression obtained from other empirical studies that the EU is characterized empirically by economic convergence. However, the process of convergence has not been stable, neither across time nor across countries.

4.6. A stylized growth model

In this section, a stylized growth model is developed that conveniently incorporates the alternative theoretical approaches presented in section two of this chapter. The model will be used as the theoretical basis for the subsequent econometric analysis. The model is in the neoclassical tradition of Solow (1956) and, more recently, Barro and Sala-i-Martin (1992) and Mankiw et.al. (1992). The formulation of the production function follows Ethier (1982) and Romer (1987). The treatment of the technological gap is based originally on Nelson and Phelps (1966) and follows De la Fuente (1995a,b) and Hansson and Henrekson (1994a). The aggregate production function is assumed to be given by

$$Y = AK^{\alpha+\mu}N^{1-\alpha} \tag{4.11}$$

where Y is GDP, K is the capital stock and N is total employment. A denotes an index for the level of technology. μ denotes an externality and describes the substitutability between different intermediate capital goods. Taking logs of equation (1) and differentiating with respect to time, we obtain the rate of growth of aggregate GDP, g_Y, as the weighted sum of three components, reflecting, respectively, the rate of technical progress g_A, the accumulation of reproducible factors g_K, and population growth g_N[18].

$$g_Y = g_A + \alpha g_K + \beta g_N \tag{4.12}$$

In order to describe economic growth in the economy, we need to specify the determinants of the three growth rates, g_A, g_K and g_N. g_N, the rate of population

growth, is exogenous. Let g_N equal n. Let's turn to the second factor, the rate of growth of the capital stock, which is given by

$$g_K = AK^{\alpha+\mu}N^{1-\alpha} - C - \delta \tag{4.13}$$

Let k = K/AN and y = Y/AN denote the capital-labor ratio and production in efficiency units, respectively. The growth rate of the stock of capital per efficiency unit of labor, g_k, is the difference between the growth rate of the aggregate stock of capital and the sum of the rates of technical progress and population growth.

$$g_k = g_K - g_A - n = sk^{\alpha+\mu-1} - (n + g_A + \delta) \tag{4.14}$$

The rate of savings s is assumed to be constant. n and δ denote the population growth rate and the depreciation rate, respectively [$n = g_N$]. $k^{(\alpha+\mu-1)}$ is the average product of capital taking into account of the externality. The rate of factor accumulation, g_k, is given by the difference between the average product of capital and the rate of consumption, which amounts, for a constant consumption rate, to equal the investment rate, and the effective depreciation rate ($n+g_a+\delta$). The time path of capital depends crucially on its factor share $\alpha+\mu$. If $\alpha+\mu$ is less than one, then the marginal product of capital, and hence the rate of return on investment, falls with the accumulated capital stock, reducing the incentive to save and the contribution of a given volume of investment to output growth. The system then returns to the steady state level of capital, which is given by

$$k^* = \frac{1}{1-\alpha-\mu}\ln A_0 + \frac{1}{1-\alpha-\mu}\ln s - \frac{1}{1-\alpha-\mu}\ln(n+\delta+g_x) \tag{4.15}$$

In contrast, if $\alpha+\mu$ equals one, so that returns to reproducible factor inputs are constant, the rate of return on investment remains constant and the incentive to save is not reduced with an increasing capital stock. Initial deviations from the steady state are persistent and remain constant. If $\alpha+\mu$ is greater than one, since the return on investment is an increasing function of the stock of capital per efficiency unit of labor, the rate of accumulation of g increases with k. Thus, k grows when it is larger than k* and falls when it is smaller, moving farther and farther away from the steady state. Finally, we specify the determinants of the rate of technical progress, g_A. Here we partly endogenize technical progress by assuming that it depends at any time t on the opportunity to exploit existing

technological differences, which in turn is associated with the social capability of the economy. As discussed before, the general idea is that backward countries will have an opportunity to embark on a catching-up process by imitating and borrowing superior production techniques from the more advanced economies cheaper and faster than the original discovery and testing. The difference between potential technological spillover and the actual spillover may be captured by assuming that in every period the relative change in the technological level is proportional to the technological gap b. The technological gap b is measured by the log difference between a "technological frontier" denoted by X and the country's own technological index, A:

$$g_A = \Phi(s)\frac{X - A}{A} \cong \Phi(s)(\ln X - \ln A) = \Phi(s)b \qquad 0 \leq \Phi \leq 1 \tag{4.16}$$

s denotes the social capability. Φ(s) measures the speed of diffusion of new technologies and is assumed to be positively related to the social capability of the country, i.e., Φ'(s) > 0. Assuming that X grows at the constant rate g_X and solving the resultant differential equation, we obtain the time path of the technology index A[19].

$$A_t = \left(A_0 - \frac{\Phi(s)}{\Phi(s) + gx}\right)e^{-\Phi t} + \frac{\Phi(s)}{\Phi(s) + gx}e^{g*t} \tag{4.17}$$

The second term on the right hand side denotes the evolution of A in the steady state (A*), while the first term captures the part of the evolution that is attributable to the out-of-steady-state effect. The steady state technological gap is given by

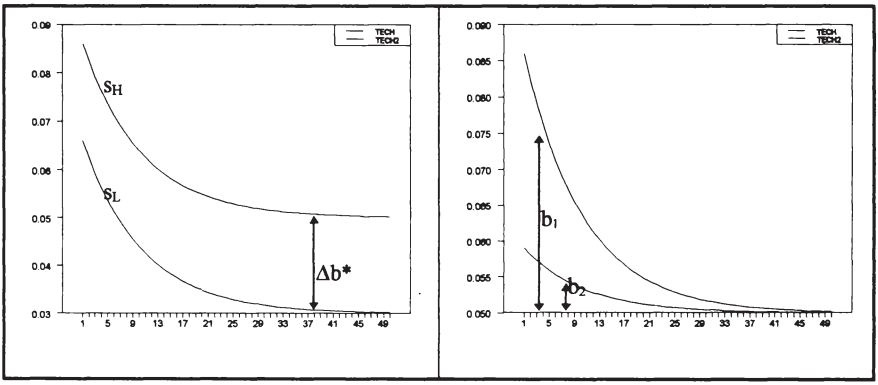
$$b^* = \frac{g_x}{\Phi(s)} \tag{4.18}$$

It follows that increased social capability reduces the steady state technological gap in a country. Two cases, displayed in Figure 8 illustrate the diffusion mechanism inherent in equations (16) to (18)[20]. For one, consider two countries with different social capabilities, s_H and s_L, but with the same initial technological gap. In this case the country with the higher level of social capability will have a faster rate of productivity growth. Eventually, the steady state growth rate g_x is reached in both countries, and the technological gaps

converge to the steady state values corresponding to the respective levels of social capability. Put differently, conditional on different initial levels of social capability, countries move to the same steady state technological gap. Alternatively, consider two countries with the same social capability level, but with initially differing technological gaps b_1 and b_2. The country with the larger technological gap will grow faster than the country with the smaller gap, but both countries eventually converge to the same equilibrium gap b^*. The differences in productivity growth rates thus remain temporary, dependent on the technological distance prevailing in the economy.

In sum, the model provides a formal synthesis of the three alternative theoretical approaches discussed in section two. The model incorporates two convergence mechanisms, the neoclassical convergence one due to decreasing returns to scale to reproducible factors, and a technological diffusion convergence one due to differences across countries to the respective steady state technological gaps. The model predicts, under plausible assumptions, what Barro and Sala-i-Martin (1991,1992) labeled *conditional convergence*[21]. There is convergence in the sense that each country approaches its long-run equilibrium in which its income per capita remains constant over time at a level determined by its investment effort [De la Fuente, 1995a]. During the transition process, growth rates may differ across countries. Growth rates may differ due to differences in initial capital intensities. In addition, they may vary due to technological differences.

Figure 4.8.: Evolution of technological gap



Source: Own calculations.

4.7. Econometric analysis

In this section a structural econometric model is estimated applying the concept of conditional convergence. The econometric analysis allows to obtain a deeper view of the causes of economic convergence. The econometric model is based on the stylized growth model developed above and concentrates on output per capita as a measure for living standards.

4.7.1. Model specification

The neoclassical growth model suggests that economies are converging to a common rate of technical change. The conditional convergence equation that has been applied by, for instance, by Mankiw et.al. (1992), and that has been used frequently in subsequent empirical research on convergence, is of the following form (all values in logs):

$$\ln y_t - \ln y_0 = (1-e^{-\lambda t})\ln y_0 + \frac{\alpha+\mu}{1-\alpha-\mu}(1-e^{-\lambda t})s_k^* + (1-e^{-\lambda t})\ln A_0 - \frac{\alpha+\mu}{1-\alpha-\mu}(1-e^{-\lambda t})(n+g_x+\delta) + A^* e^{g_x t} + v_t \quad (4.19)$$

with $\lambda = (1-\alpha-\mu)(n+g+\delta)$.

According to equation (19), the growth rate of income per capita is a function of the determinants of the ultimate steady state and the initial level of income. Mankiw et.al. (1992) approximate equation (19) with a regression of the form

$$\Delta y_t = const. + \beta_1 y_{t1} + \pi_1 (I/Y)_t + \pi_2 (n+0.05) + v_t$$

Δyt	=	$\ln y_t - \ln y_0$
const.	=	$(1-e^{-\lambda\tau})A_0 + g(t_2 - e^{-\lambda\tau} t_1)$
β_1	=	$(1-e^{-\lambda\tau})$
π_1	=	$+\frac{\alpha+\mu}{1-\alpha-\mu}(1-e^{-\lambda t})$
π_2	=	$-\frac{\alpha+\mu}{1-\alpha-\mu}(1-e^{-\lambda t})$
I/Y	=	s^*_k

Mankiw et.al. (1992) hold differences in the countries' steady states constant by the country-specific savings rates of reproducible capital, and by the average growth rate of working-age population. Their approximation relies on the assumption of equal initial levels of technology across economies. Since the technology parameter A_0 is defined in a broad sense, which includes resource endowments, institutions etc., it is not convincing that these factors should not vary across economies. In addition, the rate of technical change is assumed to be equal across economies. As Keller (1995) points out, in order to evaluate neoclassical and endogenous growth models, it is important to allow for technological differences in rates of technical change as they, presumably, in models with endogenous technical change, vary across economies. From equation (19), solving for ln y_t yields

$$\ln y_t = e^{-\lambda t}\ln y_0 + \frac{\alpha+\mu}{1-\alpha-\mu}(1-e^{-\lambda t})s_k^* + (1-e^{-\lambda t})\ln A_0 - \frac{\alpha+\mu}{1-\alpha-\mu}(1-e^{-\lambda t})(n+g_x+\delta) + A^* e^{g_x t} + v_t \tag{4.20}$$

Here, equation (20) is approximated as follows:

$$\Delta y_t = \chi + \beta_1 y_{t-1} + \pi_1 (I/Y)_t + \pi_2 (n+0.05) + \mu_i + \varphi_t + v_t \tag{4.21}$$

where

y_t	=	$\ln(y_t)$
y_{t-1}	=	$\ln(y_0)$
β_1	=	$e^{-\lambda\tau}$
π_1	=	$+\frac{\alpha+\mu}{1-\alpha-\mu}(1-e^{-\lambda t})$
π_2	=	$-\frac{\alpha+\mu}{1-\alpha-\mu}(1-e^{-\lambda t})$
$(I/Y)_t$	=	s^*_k
$\chi+\mu_i$	=	$f(A_{0i})$
φ_t	=	$f(g_t)$

The Appendix contains a formal derivation of this equation from the model specified before. Note a few things about this specification: first, following Islam (1995), initial levels of technology may vary across economies ($\mu=\mu_i$). μ_i refers to an economy-specific random shock which is constant over time. It measures the initial levels of technology A_0 in the economies. Differences in initial levels

of technology may lead to a technological catch-up process, which this specification thus incorporates implicitly. Second, φ_t is a time-specific random shock common to all economies. It is supposed to capture time-specific technological shocks, which presumably affect the economies similarly. Third, the equation conditions for differences in savings rates of reproducible capital, and for country-specific population growth rates. Physical capital's savings rate, s*k, is proxied by the average share of real investment in real GDP. Fourth, as in Mankiw et.al. (1992), $(g+\delta)$ is assumed to be equal to 0.05 and to be the same for all countries and all years.

This specification is a more general version of the model estimated by Mankiw et.al. (1992). In contrast to their approach, and based on the theoretical model developed before, technological differences are allowed for [Islam, 1995; Keller, 1994, 1995]. Initial levels of technology may vary across economies, thereby allowing for differences in employed technologies. I deviate from the model presented above in that "social capability" is not attempted to measure, being taken exogenously.

4.7.2. Econometric methodology

Equation (21) is a dynamic panel regression model. Panel data econometric methods are thus applied. Panel data analysis has several advantages [Keller, 1995]: first, by breaking up the period of observation into subperiods, the number of data points is increased. More data improves the fit of the estimation, as measured by the coefficient of determination, R^2. In addition, statistical inference is facilitated in a panel context. If N is the size of the cross-section, and T the number of time periods the cross-section is observed, then switching from cross-sectional to panel analysis increases the number of degrees of freedom from N to NT. Secondly, a panel approach exploits the time dimension of the data in a way cross-sectional analysis does not, as the latter does preclude any analysis into the time dimension of the convergence phenomenon. Thirdly, and most importantly, panel data analysis controls for economy-specific effects which, if present and not orthogonal to the other regressors, will bias the estimated coefficients. This bias is the standard omission-of-variable bias: if there is unobserved heterogeneity across economies, failing to control for this will bias the coefficients of the remaining variables according to their "true" correlation with the unobserved heterogeneity. Following Islam (1995) and Keller (1995), the individual effects are thought of as deterministic. In contrast, treating the individual effects as random would imply an assumption that the exogenous

regressors be uncorrelated with the fixed effects. This, however, would not be suitable in the present case, because it is against the argument of the economic model, as the individual-specific effects capture technological differences, which are correlated with the exogenous variables. In the present case, the Least Squares Dummy Variable (LSDV) may be applied. This amounts to introducing a dummy for each economy, and subperiod, and estimate the equation by OLS. As has been shown by Anderson and Hsiao (1982) and Hsiao (1986), the estimator of β is inconsistent when asymptotics are considered in the direction of $N \rightarrow \infty$. However, in the direction of $T \rightarrow \infty$, the LSDV estimator is consistent and asymptotically equivalent to the Maximum Likelihood Estimator [Amemiya, 1967]. A consistent estimate of β can be obtained by using instrumental-variable methods. The instrumental-variable method proposed by Anderson and Hsiao (1982) involves estimating equation (8) in differenced form, with the fixed effects being swept out[22]. Therefore, I proceed by estimating equation (8) using the LSDV-estimator in order to obtain the fixed effects. Indeed, Islam (1992) applied Monte-Carlo methods and showed that the LSDV-estimator performs very well in comparison to other estimators.

4.7.3. Estimation results

The observation period spans 42 years from 1950 to 1992 using data from 15 countries. The whole period is divided into eight sub-periods, thus seven sub-periods over a length of five years and one over seven years. At first, the observations are treated as if they were 120 independent draws from a given population. That is, regressions abstract from the fact that every 15th observation comes from the same region, and that every 8th observation belongs to the same subperiod. I then add, sequentially, country-specific and time-specific effects to allow for a less restrictive version of the econometric model, which takes into account of differences across economies and across time[23].

The results from estimating equation (21) are given in Table 7. In the upper part of the table results from unrestricted regressions are displayed. In the lower part of the table, results from restricted regressions, imposing the (neoclassical) restriction that the coefficients of the investment and population growth rates are equal in magnitude but opposite in sign ($\pi_1 = - \pi_2$), are given.

The first column gives the results from estimating equation (21) with pooled ordinary least squares [regression (1)]. The signs of the coefficients are as to be expected from economic theory. Physical capital's investment rate has a positive and significant effect on output per capita. The coefficient of the rate of

Table 4.7: Regression results from estimating equation (21)

	y_tOLS (1)	y_tLSDV (2)	y_tLSDV (3)	y_tLSDV (4)	y_tLSDV (5)
constant	0.7047 (0.1870)	-	-	-	-
$\ln (y)_{t-1}$	0.9085 (0.0125)	0.9269 (0.0119)	0.8780 (0.0171)	0.9271 (0.0186)	0.6774 (0.0442)
$\ln (I / GDP)_t$	0.0767 (0.0345)	0.2309 (0.0478)	0.1184 (0.0537)	-0.0234 (0.0525)	-0.0168 (0.0533)
$\ln (n + g + \delta)_t$	0.0057 (1.677)	0.8745 (1.9767)	-1.4025 (1.9418)	0.6703 (1.5279)	2.5546 (1.5332)
Implied λ	0.01827	0.0144	0.02478	0.0144	0.0548
R^2 adj.	0.98	0.98	0.98	0.96	0.98
Durbin - Watson	1.56	1.78	1.68		1.80
s.e.e.	0.065	0.067	0.062		0.054
Restricted Regression					
constant	0.7089 (0.1661)	-	-	-	
$\ln (y)_{t-1}$	0.9083 (0.0122)	0.9267 (0.0119)	0.8811 (0.0164)	0.7761 (0.0184)	0.6789 (0.0442)
$\ln (I / GDP)_t - \ln (n+g+\delta)_t$	0.0772 (0.0331)	0.2507 (0.0326)	0.1045 (0.0494)	-0.0220 (0.0510)	0.0027 (0.0520)
Implied λ	0.01832	0.0145	0.02411	0.0482	0.0737
R^2 adjusted	0.98	0.98	0.98	0.98	0.98
Durbin-Watson	1.56	1.77	1.69	1.86	1.75
s.e.e.	0.064	0.067	0.0626	0.056	0.055
Wald test for neoclassical restriction : p-value	0.96	0.64	0.50	0.08	0.09
Test for relative fixed effects and neoclassical restriction : p-value		0.57		0.02	
Individual Fixed Effects Included	No	Yes	Yes	Yes	Yes
Time Fixed effects included	No	No	No	Yes	Yes
LR-tests for significance of fixed effects					
H_0: No individual fixed effects $\chi^2(15)$: p-value			0.0013		
H_0: No time fixed effects $\chi^2(8)$: p-value				0.013	0.0001
Standard errors in parantheses. P-value refers to marginal significance level. Heteroskedasticity-consistent errors are used. [White 1980].					

Source: Own calculations.

population growth remains insignificant. The coefficient of the log of output per capita in the previous sub-period is 0.9, which implies a rate of convergence of 1.82 per cent p.a.[24]. The value is within the range of estimates obtained by other authors using cross-section regression analysis with regional European data. Barro and Sala-i-Martin (1991), for example, obtained a corresponding speed of 1.78 per cent p.a., while Armstrong (1995) reports rates between 1 and 2 per cent p.a..The estimated coefficients from restricted regressions are similar as before. The restriction is accepted, with a probability of 96% that the restriction is correctly imposed. The second and third column [regressions 2 and 3] contain the results from estimating equation (21) with individual-specific fixed effects, thus allowing for differences in initial states of technology. A dummy for each economy is included, which effectively introduces a constant term for each country. In the second column [regression 2] the fixed effects are restricted to sum to zero, thus expressing initial technology relative to an EU-average. The rate of convergence drops to 1.44 per cent p.a. in the unrestricted and to 1.45 per cent p.a. in the restricted regression. In the third column [regression 3] the fixed effects are expressed in absolute terms. The rate of convergence now increases to 2.47 per cent p.a., thus by inclusion of individual-specific fixed effects the rate of convergence is enhanced. As before, the neoclassical restriction (i.e. opposite signs of coefficients of population growth and investment rates) is accepted. It remains to test for the significance of the fixed effects, thus for the significance of differences in initial levels of technology. The corresponding Likelihood Ratio (LR)-test rejects the hypothesis of no fixed effects at the 1% significance level. The fourth and fifth column [regressions 4 and 5] display the results from esimating equation (21) with both individual- and time-specific effects. In the fifth column the fixed effects are again expressed in absolute terms. The rate of convergence is now 5.48 per cent p.a.. Thus, conditioning on time-specific shocks does contribute to a more than double of the rate of convergence indicating that time-specific factors, like the oil-crises, are very relevant for differences across economies. The LR-test for significance of time-specific effects confirms that they are statistically significant for convergence and growth in the EU.

Next I turn to the issue of human capital. Human capital has been assigned several roles in the literature on economic growth [Hansson and Henrekson, 1994a]. First, it is seen as a separate factor of production, e.g., Mankiw et.al. (1992). Second, it is a source of innovative activity, and therefore an important input in the production of basic knowledge [Romer, 1990]. Third, a larger stock of human capital makes it easier for a country to absorb the new products or

of human capital makes it easier for a country to absorb the new products or ideas that have been discovered elsewhere, and hence the catching-up potential may be exploited (Nelson and Phelps, 1966; Easterlin, 1981; Abramovitz, 1986]. Fourth, there may be an external effect of human capital, i.e. human capital embodied in a worker may raise the productivity of colleagues [Lucas, 1988]. The regression equation including human capital then becomes

$$(4.22) \qquad \Delta y_t = \chi + \beta_1 y_{t-1} + \pi_1 (I/Y)_t + \pi_2 (n + 0.05) + \pi_3 \ln(s_h) + \mu_i + \varphi_t + \nu_t$$

The savings rate of human capital is approximated by the tertiary school enrollment rate. For the present sample of EU economies the use of the tertiary school enrollment rate seems to more appropriate than secondary school enrollment rates, as the latter show relatively little variation across the countries.

Table 8 contains the results from estimating equation (22). In the upper part of the table results from unrestricted regression estimates are given, while in the lower part of the table restricted estimates, imposing the neoclassical restriction that the coefficients on the investment rate, the human capital accumulation rate and the population growth rate sum to zero, are provided.

In the first column the results from pooled regression estimates are displayed [regression 6]. The value of the coefficient of lagged ouput per capita is 0.9, which is similar as before in the pooled regression without human capital. Indeed, the coefficient of human capital accumulation turns out to be insignificant. Imposing the neoclassical restriction, which is accepted, does not affect the estimated coefficients. Next economy-specific fixed effects are included [regressions 7 and 8]. The coefficient of lagged output per capita drops to 0.75, thus the rate of convergence rises to 5.72 per cent p.a.. The value of the coefficient of human capital accumulation now rises and becomes clearly significant. One interpretation for this finding may be that the initial level of technology is correlated with the rate of human capital accumulation, as proposed by some endogenous growth models [Lucas 1988]. The LR-test indicates that the individual-specific fixed effects are statistically significant. Finally, in regressions 9 and 10, the full two-way fixed effects structure is included. The coefficient of human capital becomes insignificant, which may suggest the partial correlation between human capital and output per capita is time-sensitive. A possible interpretation, noted by Andrés et.al. (1995), is that the human capital influence upon output takes time to show up, and hence it might be the case that changes in the tertiary school enrollment rate are weakly correlated with current output per capita. The rate of convergence becomes 7.62 per cent p.a., thus by

Table 4.8.: Regression results from estimating equation (22)

Regressors / Estimators	y_{tOLS} (6)	$y_{tr\ SDV}$(7)	$y_{tr\ SDV}$(8)	$y_{tr\ SDV}$(9)	$y_{tr\ SDV}$(1)
constant	0.7278 (0.2173)	-	-	-	-
$\ln (y)_{t-1}$	0.9055 (0.0156)	0.8827 (0.0149)	0.7507 (0.0312)		0.6700 (0.043)
$\ln (I / GDP)_t$	0.0724 (0.0456)	0.2802 (0.0450)	0.0523 (0.0654)		-0.0174 (0.053)
$\ln (s_k)_t$	0.0035 (0.0122)	0.0469 (0.0127)	0.0897 (0.0155)		0.0180 (0.0209)
$\ln (n + g + \delta)_t$	0.1350 (1.7960)	2.4583 (2.1768)	1.3972 (2.1880)		2.8522 (1.6222)
Implied λ	0.0189	0.0237	0.0546		0.0762
R^2 adj.	0.98	0.97	0.98		0.98
Durbin - Watson	1.56	1.80	1.94		1.81
s.e.e.	0.0654	0.0737	0.0572		0.0551
Restricted Regression					
constant	0.7318 (0.2147)	-	-	-	-
$\ln (y)_{t-1}$	0.9054 (0.0156)	0.8886 (0.0142)	0.7515 (0.0312)	0.7460 (0.0266)	0.6731 (0.0434)
$\ln (I / GDP)_t$-$\ln (n+g+\delta)_t$	0.07524 (0.0390)	0.3206 (0.0325)	0.0703 (0.0603)	-0.0105 (0.0519)	0.0032 (0.0523)
$\ln (s_k)_t$-$\ln (n + g + \delta)_t$	0.0032 (0.0120)	0.0382 (0.0108)	0.0857 (0.0145)	0.0267 (0.0185)	0.0091 (0.0203)
Implied λ	0.0189	0.0224	0.0544	0.0558	0.0754
R^2 adj.	0.98	0.97	0.98	0.98	0.98
Durbin-Watson	1.56	1.75	1.89	1.86	1.75
s.e.e.	0.0650	0.0740	0.0572	0.057	0.056
Test for neoclassical restriction: p-value	0.905		0.47	0.098	0.077
Test for rel. Fixed. Eff. And neoclassical rest. : p-value		0.0001		0.022	-
Individual Fixed Effects Included Time Fixed effects included	No No	Yes No	Yes No	Yes Yes	Yes Yes
LR - tests for significance of fixed effects					
H_0: No individual fixed effects $\chi^2(15)$: p-value			0.0001		
H_0: No time fixed effects $\chi^2(8)$: p-value				0.0001	0.0001
Standard errors in parantheses. P-value refers to marginal significance level. Heteroskedasticity-consistent errors are used. [White 1980].					

Source: Own calculations.

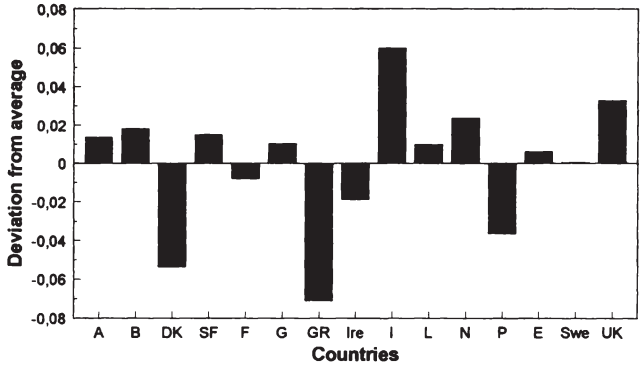
taking into account of time-specific shocks the speed of convergence is increased. Time-specific effects are significant, as indicated by the LR-test. The neoclassical restriction is, as before, accepted.

In sum, while, on the one hand, the results tend to accept the restrictions suggested by the neoclassical growth model, differences, on the other hand, in initial states of technology are found to play an important role for the post-World War II growth experience in the EU. Thus, the process of convergence is influenced by differences in technology levels. By taking into account of these differences, the rates of convergence are increased. In other words, with respect to the hypotheses formulated above, the estimation results are essentially in line with a model of decreasing returns to scale and opportunities for technological catch-up.

4.7.4. Economic interpretation

In this section I attempt to deepen the economic interpretation of the estimation results discussed in the previous section and to derive some of their economic implications.

Figure 4.9 :
Estimated fixed effects



Source: Own calculations.

Figure 9 displays the estimated economy-specific fixed effects obtained from regression 10, which included the full two-way fixed effects structure[25]. The coefficients are presented relative to their average values. Apart from the strongly negative deviation of the initial level of technology in Denmark, for which I do not find a plausible explanation, the estimated values seem reasonable. The estimated levels of technology are clearly below the average in Greece, Ireland and Portugal, and deviate positively, in particular, in Italy and Belgium from the average.

In Table 9 the correlation coefficients between the estimated fixed effects and the levels of GDP per capita in different years are given. Since A_0 is part of the production function, it should be correlated with per capita income at different points of time. As expected, the correlation is strongly positive, indicating that a higher initial level of technology implies a higher living standard in the future. Interestingly, the correlation seems to become stronger, the longer the period to the observed income per capita is.

Table 4.9. Analysis of estimated fixed effects. Correlation coefficients

Variable	Fixed effect (3)[a)]	Fixed effect (5)[a)]	Fixed effect (8)[a)]	Fixed effect (10)[a)]
$\ln y_{50}$	0.39	0.25	0.28	0.25
$\ln y_{60}$	0.49	0.35	0.34	0.35
$\ln y_{73}$	0.47	0.43	0.39	0.42
$\ln y_{91}$	0.57	0.46	0.42	0.45
$\Delta \ln y_{(91-50)}$	-0.19	- 0.05	- 0.13	- 0.05
$\Delta \ln y_{(73-50)}$	-0.22	- 0.01	- 0.11	- 0.01
s_k Tertiary enrollment rate (average)	0.23	0.28	0.29	0.28
s_k Secondary enrollment rate (average)	0.02	- 0.08	0.09	- 0.07
$\ln (I/Y)_{(90-50)}$	0.05	0.11	0.24	0.12
$\ln n_{(90-50)}$	- 0.06	0.18	0.03	0.17
$\ln (G/Y)_{(90-50)}$	- 0.12	- 0.31	- 0.26	- 0.32
a) Estimated fixed effects obtained from the regression in parantheses, referring to Tables 7 and 8.				

Source: Own calculations.

Turning to the relation between the initial level of technology and the subsequent rate of growth, one needs to think first about what to expect from economic theory[26]. With no technological diffusion, a technologically leading economy always has a higher rate of productivity growth. The distance between the technological leader and its follower grows without bound. This would be the case in endogenous growth models, where differences in initial levels of technology are allowed for and which remain persistently different.

With technological diffusion, on the other hand, the initial technological gap between two economies is reduced over time and the rate of productivity growth is equalized. Though I do not have a measure for the rate of productivity growth, the rate of growth of GDP per capita may serve as a proxy. In addition, Table 9 contains the correlation coefficients between the rate of growth and the estimated initial levels of technology are given, which turn out be negative. Thus a higher initial level of technology is associated with a relatively lower subsequent growth rate. This result confirms the impression of the estimation results in the sense that initially, in terms of technology, backward economies tended to catch-up to technologically advanced ones[27].

An interesting question relates to the determinants of technological differences. According to endogenous growth theories, factors like market size, economic policies, or factor endowments may affect technology and growth. To obtain an impression, I calculate correlation coefficients between several explanatory variables and the estimated technology parameters. In addition to the variables used in the regressions (physical and human capital, population growth rates), I put the initial levels of technology in relation to the size of the government (G/Y), which may be thought of as proxy for institutional differences. The results are displayed in the lower part of Table 9. Tertiary school enrollment rates show the strongest positive partial correlation with the estimated fixed effects. While both investment rates and population growth rates are positively correlated, the relation to the size of the government is negative. Barro (1991) and Landau (1983, 1986) report negative coefficients in cross-sectional analyses between the average growth rate and the size of the government, which is in line with the negative correlation coefficients. The results here, suggest, interpreted with all necessary caution, that the mechanism may work through the effect on technological parameters. More research, however, on the determinants of technological differences is needed to obtain more reliable empirical evidence.

4.8. Concluding remarks

This chapter contains an empirical analysis on growth and convergence in the European Union. The chapter starts from a discussion of the relevant theoretical background. Three modern theories of economic growth are discussed. Theories of technological catch-up argue that inefficient use of technology may lead to a process of convergence, depending on the degree of economic development in the economy. Neoclassical growth theories predict convergence due to decreasing returns to scale. Endogenous growth theories, in contrast, maintain that economic growth may be influenced by factors like market size, economies of scale and institutional structure, so that differences in living standards would possibly persist. It is argued that the predictions of theoretical models concerning the prospects for income convergence across countries depend crucially on two assumptions: the existence, or non-existence, of increasing returns to reproducible factors, including the stock of technological knowledge, and the degree to which useful knowledge is a public good across countries.

As for the controversy on the right measure of convergence, theoretical and empirical concepts of convergence are reviewed. First, σ-convergence considers the cross-sectional dispersion in per capita earnings. σ-convergence occurs if the cross-sectional dispersion in per capita earnings, typically measured by either the standard deviation or the coefficient of variation, declines through time. Second, absolute β-convergence occurs when poor countries tend to grow faster than rich ones, such that poor countries catch up to rich ones in terms of the level of per capita output through time. Third, conditional convergence refers to convergence after it has been controlled for differences in the economy's steady states. With conditional convergence, each country may converge to its own steady state, which could be very different from each other. Hence, a high degree of inequality among economies could persist, even in the long-run, and one could observe high persistence in the relative positions of the different economies. Finally, a concept that analyses the evolution of the distribution of income over time has been applied. The economic basis of the concept is that economies in an integrated world tend to be increasingly interdependent units, which would make it necessary to drop the "representative economy" assumption inherent in neoclassical approaches.

The empirical evidence with respect to convergence in the world economy is mixed. However, there exists a broad consensus in the more recent literature suggesting an absence of convergence to a single steady state. The absence of convergence to a single steady state may be explained either in the neoclassical

tradition in terms of conditional convergence, that is, the rate of growth falls as the economy approaches its own long-run level, or in terms of local convergence and multiple equilibria. Empirical studies for Europe tend to support the convergence hypothesis.

The chapter continues with an analysis of the stability of growth and convergence processes in Europe, using descriptive statistical techniques and alternative methods to measure convergence. The results obtained may be summarized as follows: first, the adjustment process of goods markets in Europe, on a regional level, is slower than across countries. This is in line with other empirical evidence concerning goods- or labor market-adjustment in the EU and implies that lagging economic regions in the EU have greater difficulties to cope with region-specific structural adjustment problems than countries with country-specifc ones. Second, economic convergence of output per worker in the EU over the post World-War II period is confirmed. Convergence is found by applying σ-convergence. The summed deviation from the mean across EU countries has decreased over time. However, first, σ-convergence is seen to be empirically less smooth than theoretically predicted and, second, the process of convergence seems to have been reversed since 1974. Third, while income differentials have been reduced among middle- and high-income economies, differentials to a group of poor economies remain persistent. Thus, while on average European economies seem to converge, this process no common to all economies. The descriptive analysis in this section, thus, confirms the impression obtained from other empirical studies that the EU is characterized empirically by economic convergence. However, the process of convergence has not been stable, neither across time nor across countries.

The subsequent econometric analysis of the relation between technological differences, convergence, and growth suggests that over the post World-War II period European economies have been converging in terms of output per capita in a conditional sense. Other things equal, poor countries in Europe tend to grow faster than richer ones. Conditional on equal investment, enrollment rates and technologies, economies in Europe do seem to converge to the same level of income per capita. The finding of conditional convergence, however, does imply that at present economies living standards in Europe diverge. In other words, since investment rates, enrollment rates, and employed technologies differ across EU countries, economies converge, dependent on these determinants, to individual levels of output per capita. It follows that poor economies, like Portugal, Greece, Spain and Ireland, presumably converge to a lower steady state

level of income per capita, which implies persistent differences in income per capita.

Technological differences are found to be an important factor for our understanding of growth and convergence in the European Union. The empirical evidence seems to support a model with technological diffusion, in which technologically lagging economies manage to catch-up to technological leaders by innovating and imitating at a lower cost. The exhaustion of catch-up opportunities, associated with initial technical backwardness, in addition, may be a factor that helps to explain the slowdown of growth and convergence in more recent years.

The estimation results tend to suggest that living standards in Europe are unlikely to equalize over time, as there will remain a group of about four countries that converges to a relatively lower steady state. If we think of the responsibility of policymakers to reduce disparities in Europe, based on Article 130a of the Maastricht Treaty, the estimates indicate that extended fiscal transfers may be needed to secure this policy goal. However, at the same time it needs to be emphasized that cohesion does not require that incomes or social conditions should be equalized. Nevertheless, if gaps are too large, it is plain clear that it will be difficult for the Community to be cohesive. Therefore, plausible targets for reductions in disparities, which pass the test of being politically acceptable, would be helpful[28].

Appendix to Chapter 4

1. Derivation of convergence equation

In this appendix the convergence regression equation, which is given in the main text as equation (21), is derived. The derivation is based on the stylized growth model presented in the main text. An alternative derivation may be found in De la Fuente (1995a). A derivation of the convergence equation from the neoclassical growth model is, for instance, in Barro and Sala-i-Martin (1995a). We start from the dynamic equation describing the evolution of the capital stock per efficiency unit.

$$(A.1) \qquad g_k = sk^{\alpha+\mu-1} - (n + g_A + \delta)$$

where s is the constant savings rate in the economy. The rate of technical progress, g_A, is given by

(A.2) $$g_A = \Phi(s)((X - A) / A \cong \Phi(s)(\ln X - \ln A) = \Phi(s)b$$

where b = ln X - ln A denotes the technological gap between the actual technology level in economy i and its technological frontier. We assume that the technological frontier X grows at a constant exogenous rate, g_X, which is identical across countries. The rate of change of the technological gap, g_b, is then given by the difference of the growth rate of the best-practice technology and the rate of technical progress.

(A.3) $$g_b = g_X - g_A = g_X - \Phi(s)b$$

Equations (2) and (3) are both linear, first-order differential equations describing the dynamic behavior of the rate of technical progress and the technological gap, respectively. By solving equation (2), we obtain the time path of the technology index.

(A.4) $$A_t = [A_0 - \Phi(s) / (\Phi(s) + g_x)]e^{-\Phi t} + [\Phi(s) / (\Phi(s) + g_x)]e^{g_x t}$$

The second term on the right hand side denotes the evolution of A in the steady state (A*, the particular solution), while the first term captures the part of the evolution that is attributable to the out-of-steady-state effect (complementary solution). From equation (3), we obtain the time path of the technological gap.

(A.5) $$b_t = \left[b_0 - \frac{gx}{\Phi(s)}\right]e^{-\Phi(s)t}$$

Asymptotically, the technological gap converges to a steady state value, $b^* = \frac{g_x}{\Phi(s)}$, which depends negatively on the speed of technological diffusion and on the social capability of the economy. From equation (1), we obtain the steady state value of the stock of capital per efficiency unit.

(A.6) $$k^* = \frac{1}{1-\alpha-\mu}\ln A_0 + \frac{1}{1-\alpha-\mu}\ln s - \frac{1}{1-\alpha-\mu}\ln(n + \delta + g_x)$$

Substituting (2) into (1), and dividing by k, we obtain

(A.7) $$g_k = sk^{\alpha+\mu-1} - (n + \Phi(s)b + \delta)$$

We may rewrite equation (7) as follows.

(A.8) $$\ln g_k = se^{k^{\alpha+\mu-1}} - (n + \Phi(s)b + \delta)$$

Evaluating the partial derivatives of equation (8) at the steady state, we get

(A.9) $$F_k = -(1-\alpha-\mu)\cdot(n + g_x + \delta) \equiv -\lambda \qquad F_b = -\Phi(s)$$

Equation (8) can thus be approximated by the log-linear equation

(A.10) $$gk = -(k - k^*) - \Phi(s)(b - b^*)$$

From equation (10), and using (5), we obtain the time path for the capital stock per efficiency unit.

(A.11) $$k_t = k^* + e^{-\lambda t}(k_0 - k^*) + e^{-\Phi(s)t}(b_0 - b^*)$$

We may rewrite equation (11) as in

(A.12) $$k_t = \left(1 - e^{-\lambda t}\right)k^* + e^{-\lambda t}k_0 + e^{-\Phi(s)t}(b_0 - b^*)$$

The time path of (the log of) output per capita is given by

(A.13) $$y_t = A_t + (\alpha + \mu)k_t$$

Substituting equation (12) into equation (13), we obtain

(A.14) $$y_t = A_t + (\alpha + \mu)\left(1 - e^{-\lambda t}\right)k^* + e^{-\lambda t}k_0 + e^{-\Phi(s)t}(b_0 - b^*)$$

We may rewrite equation (14), using (13), as follows:

(A.15) $$y_t = A_t + (\alpha + \mu)\left(1 - e^{-\lambda t}\right)k^* + e^{-\lambda t}(y_0 - A_0) + (\alpha + \mu)e^{-\Phi(s)t}(b_0 - b^*)$$

Substituting equation (4), the expression for the time path of the technology index, into equation (15) we see that

$$\text{(A.16)} \qquad \begin{aligned} y_t &= (A_0 - A^*)e^{-\Phi(s)t} + A^* e^{gxt} + (\alpha+\mu)(1-e^{-\lambda t})k^* \\ &+ e^{-\lambda t} y_0 - e^{-\lambda t} A_0 + (\alpha+\mu)e^{-\Phi(s)t}(b_0 - b^*) \end{aligned}$$

Substituting the expression for the steady state capital stock into equation (16), and rearranging, we arrive at

$$\text{(A.17)} \qquad \begin{aligned} y_t &= A_0(e^{-\Phi(s)t} - e^{-\lambda t}) + (\alpha+\mu)e^{-\Phi(s)t} b0 + A^* e^{gxt} \\ &- e^{-\Phi(s)t}[b^*(\alpha+\mu) + A^*] + e^{-\lambda t} y_0 + (1-e^{-\lambda t})\left(\frac{\alpha+\mu}{1-\alpha-\mu}\right) Sk^* \\ &- (1-e^{-\lambda t})\left(\frac{\alpha+\mu}{1-\alpha-\mu}\right)(n+g_x+\delta) \end{aligned}$$

We subtract y_0 on both sides, to obtain

$$\text{(A.18)} \qquad \begin{aligned} y_t - y_0 &= A_0(e^{-\Phi(s)t} - e^{-\lambda t}) + (\alpha+\mu)e^{-\Phi(s)t} b0 + A^* e^{gxt} \\ &- e^{-\Phi(s)t}[b^*(\alpha+\mu) + A^*] - (1-e^{-\lambda t}) y_0 + (1-e^{-\lambda t})\left(\frac{\alpha+\mu}{1-\alpha-\mu}\right) Sk^* \\ &- (1-e^{-\lambda t})\left(\frac{\alpha+\mu}{1-\alpha-\mu}\right)(n+g_x+\delta) \end{aligned}$$

We may rewrite equation (17) and (18), by rearranging, as

(A.19)

$$\begin{aligned} y_t &= (e^{-\Phi(s)t} - e^{-\lambda t})A_0 + (\alpha+\mu)e^{-\Phi(s)t} b_0 - e^{-\Phi(s)t} b^*[(\alpha+\mu) + A^*] \\ &+ A^* e^{gxt} + e^{-\lambda t} y_0 + \frac{\alpha+\mu}{1-\alpha-\mu}(1-e^{-\lambda t}) Sk^* - \frac{\alpha+\mu}{1-\alpha-\mu}(1-e^{-\lambda t})(n+g_x+\delta) \end{aligned}$$

The regression equation (21) of the main text, which is repeated here for convenience, may then be given the following interpretation:

$$y_t = \chi + \beta\, y_{t-1} + \pi_1 (I/Y) + \pi_2 (n+0.05) + \mu_i + \varphi_t + \varepsilon_{it}$$

where $y_t = \ln y_t$

$\beta = e^{-\lambda t}$

χ = $e^{-\Phi(s)t}$ [b*(α+μ) + A*]

y_{t-1} = ln y_0

π_1 = $+\frac{\alpha+\mu}{1-\alpha-\mu}(1-e^{-\lambda t})$

I/Y = s_k

π_2 = $-\frac{\alpha+\mu}{1-\alpha-\mu}(1-e^{-\lambda t})$

n+0.05 = $n+g_x+\delta$

μ_i = $(e^{-\Phi(s)t}-e^{-\lambda t})\ln A_0+(\alpha+\mu)e^{-\Phi(s)t}b_0$

φ_t = $f(g_t)$

This provides an alternative interpretation of the convergence equation, while the regression equation remains unchanged.

2. Dynamic stability

The dynamic stability of the model depends on the asymptotic behaviour of the technological gap and the capital stock. In other words, the stability of the model is based on equations (1) and (3). The partial derivates, evaluated at the steady state, are given by

(A.20) $$F=\begin{Bmatrix}-(1-\alpha-\mu)(n+g_x+\delta) & -\Phi(s)\\ 0 & -\Phi(s)\end{Bmatrix}$$

The Trace of (19) is given by

TR(A) = -(1-α-μ) (n+g_x+δ) - Φ(s)

The Determinant of A is given by

D(A) = [-(1-α-μ) (n+g_x+δ)] • (-Φ(s))

We distinguish 3 cases.

I. (1-α-μ) > 0 ; Φ > 0

$\Rightarrow$ D(A) > 0; TR(A) < 0

$\Leftrightarrow$ stable node

This is the case with decreasing returns to scale and a stable evolution towards the steady state technological gap. The model is stable.

II. $(1-\alpha-\mu) < 0 \; ; \; \Phi > 0$
$\Rightarrow TR(A) \leqq 0 \; ; \; D(A) < 0$
$\Leftrightarrow$ saddle path stable

With increasing returns to scale and technological catch-up, there exists a unique stable path towards the steady state.

III. $(1-\alpha-\mu) < 0 \; ; \; \Phi < 0$
$\Rightarrow TR(A) > 0; \; D(A) > 0$

With increasing returns to scale and technological divergence, the model is unstable. Thus, we may conclude that the stability of the dynamic system depends on the interaction between the technological catch-up process and the neoclassical convergence mechanism.

Endnotes

[1] An abbreviated version of this chapter in *International Advances in Economic Research.*
[2] This section draws heavily on Hansson and Henrekson (1994a).
[3] See also Barro and Sala-i-Martin (1995a,b) and Betis et.al. (1993) for alternative theoretical models of technological diffusion and growth. Eaton and Kortum (1995) provide simulation results for a multi-country model of technological innovation. Based on plausible assumptions about technology gaps that existed among five leading research economies, they can explain growth experiences quite successfully.
[4]For policy-oriented surveys of new growth models, see Shaw (1992), Fratianni and Haug (1995). See also the *Journal of Economic Perspectives*, Winter 1994.
[5]For a survey of different methods to test for convergence, see Hall et.al. (1993). For critical discussions of alternative empirical convergence concepts, see Friedman (1992), Bernard and Durlauf (1993), Quah (1993, 1994, 1996), Hart (1994), Lichtenberg (1994), Barro and Sala-i-Martin (1995a), Canova (1995), Cohen (1995), Sala-i-Martin (1996).
[6]For other recent surveys, see Desdoigts (1994) and De la Fuente (1995b).
[7]Baumol et. al. (1989) contains additional empirical analyses (moving averages, Gini-coefficients) using the same data set as in Baumol and Wolff (1988), which confirm the above stated result.
[8]The authors divide the sample of countries into three groups: The poor country group includes 29 countries, which are almost entirely African. The middle-income group includes 27 countries and the rich-country group 22 countries, being mainly OECD countries.
[9]Empirical studies usually resport several regressions based on different conditioning sets. Here, from each study the results from one regression are reported, usually based on the

largest number of conditioning variables used in the study. For a survey on earlier empirical evidence, see Levine and Renelt (1991). Levine and Renelt (1992) provide a sensitivity analysis of different variables and show that the results are very sensitive to the choice of variables.

[10]The countries are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Sweden, UK, USA.

[11]Club dummies are two dummies: one "lower club dummy", which refers to the poorest 25 regions in 1981 and one "upper club dummy", which refers to the richest 25 regions in 1981.

[12]The countries included are: Belgium, Denmark, Finland, Greece, Ireland, Netherlands, Portugal, Spain, Sweden, United Kingdom.

[13]The slowdown of growth and productivity in the past 20 years is a well-documented phenomenon for all OECD countries. See, for recent analyses, Ben-David (1995), Crafts and Mills(1995), Siebert (1992).

[14]This point has been emphasized for the OECD countries by Andrés et.al. (1995). See Decressin and Fatás (1994) for related empirical evidence on labor market adjustment in the EU economies.

[15]The concept of implicit σ-convergence has been used by Andrés et al. (1995). The graph for output per capita looks similar; it is not included here.

[16]See Barro and Sala-i-Martin (1995a), Chapter 11.

[17]See, for example, Dolado et.al. (1994).

[18]Here, as in the rest of the chapter, I use the notation $x' = dx/dt$ for the derivative of x with respect to time. The growth rate of x is denoted by $gx = x' / x$.

[19] See, e.g., Chiang (1984, pp.470) for solving first-order linear differential equations.

[20] In Figure 4.8. the time paths of the technology index, based on equation (4.17), are displayed. The equilibrium rate of technical progress, g_x, is assumed to be zero. The other values used are:

(a) $s_H : A_t = 0.9^{0.04t} + 0.05$
$s_L : A_t = 0.9^{0.04t} + 0.03$

(b) $b_1 : A_t = 0.9^{0.04t} + 0.05$
$b_2 : A_t = 0.9^{0.01t} + 0.05$

[21] See the Appendix for an analysis of the stability properties of the model.

[22]The third alternative estimator would be Chamberlin's minimum-distance estimator. See, for example, Chamberlin (1984).

[23]Different specifications of the econometric model were applied. In particular, estimating equation (20) in differenced form did not change the results.

[24]$\beta = e^{-\lambda\tau}$, where τ equals the average subperiod length in years. Thus, $\lambda = - \ln(\beta) / \tau$ with $\tau = 5.25$.

[25]The estimates for the fixed effects obtained from other regressions are similar.

[26]De la Fuente (1995a,b) provides a formal model for the subsequent argument.

[27]This is in line with results obtained from De la Fuente (1995) and Dowrick and Nguyen (1989). Islam (1995) obtained, for a large sample of economies, which includes developing countries, a positive correlation between the estimated technology levels and the subsequent average growth rate.

[28] See Begg and Mayes (1993) for a similar argument.

5. Conclusions and policy implications

The next couple of years may prove difficult as the European Union (EU) faces the eventual transition to monetary union. The Maastricht Treaty has created a transition-automatism towards monetary union, so that by the end of the century at least two countries will have adopted a common currency. While the legal enactment of the Maastricht Treaty represents a major step forward in the European integration process, at the beginning of 1996, it is as unclear as ever which countries will eventually join European Monetary Union (EMU). Germany may meet the requirments to join, but this does not mean that it will necessarily want to, and the same is true of England. Other countries who may wish to join, may not be allowed to do so. There is also much uncertainty surounding the eventual starting date, and the possibility still remains of postponing monetary union. Moreover, and probably most importantly, the real economic effects of a common currency are still difficult to evaluate. The economies in Europe currently exhibit immense structural differences, in terms of productivity, in wage formation mechanisms, and in living standards.

One reason for the prevailing uncertainty towards the shape of the future monetary union lies in the formulation of the Maastricht Treaty's convergence criteria itself. The Treaty has set out a path to move towards monetary union in three stages. Entry into the third, final, stage is conditional upon achieving nominal convergence in terms of inflation rate performance, budget positions, exchange rate stability and long-term interest-rates. However, the Maastricht Treaty's convergence criteria not only neglect real economic convergence, but are largely economically inconsistent (as seen in Chapter Two) and are not able to provide credibility to the future union.

Whilst a monetary union, by definition, requires nominal convergence, real economic (or structural) convergence is not a technical necessity for its functioning. However, nominal convergence will be associated with restrictions on macroeconomic policy that will prove to be an additional burden on the union, particularly on the less-prosperous members. Therefore, the union itself may reduce its own political support and widen existing structural differences. In addition, if the union consists of countries with very different equilibrium unemployment rates or productivity growth rates, its long-term stability may be threatened. Such a situation may result in transfer payments from low to high level unemployment countries or, at the least, put pressure on politicians to advocate such transfers. However, if the European Union was unwilling to provide any finan-

cial support to a country or region, the cries of politicians seeking to blame any depression on EMU can be expected. In both cases, willingness to remain within EMU may be affected. As has been argued by Goodhart (1995), the costs of withdrawing from a single currency and re-establishing a separate currency are not, in reality, as great as is generally perceived. Once the central political institutions disintegrate, as has happened in the USSR, Yugoslavia and Czechoslovakia, the costs of moving from a common to multiple currencies are of only secondary importance. The possibility of a monetary disintegration can therefore a priori not be ruled out categorically. It follows that real economic convergence - the gradual reduction of real economic differences over time - would be helpful for the working of monetary union as it would tend to restrict political frictions and thereby secure long-term macroeconomic stability.

In view of this political and economic background, this study has analyzed real economic convergence in the European Union. Through this it contributes to the discussion on the feasability of EMU and the economic effects of monetary union. Using a stepwise approach the analysis concentrated, firstly, on the dynamics of labor and goods market adjustment processes and, secondly, on long-run growth and convergence as indicators for real economic convergence.

5.1. Conclusions

The empirical evidence obtained provides an ambiguous picture as to the real economic convergence performance in the European Union. The results of the comparative analysis of the dynamics of goods and labor market adjustment processes are summarized below. The dynamic behavior of output and unemployment are found to be relatively similar in the European and the North-American countries, although demand and supply shocks in Europe tend to have somewhat more persistent effects on output and unemployment. In addition, the demand and supply shocks affecting the North-American countries are more evenly distributed than those affecting Europe. Moreover, the degree of symmetry of shocks is higher among sub-groups of countries than for the whole group of European countries. Finally, the fifteen member states of the European Union do not form an optimum currency area as a whole, as shocks affect economies relatively unevenly. Therefore, from an economic point of view, a monetary union involving all EU member countries is an inefficient idea and is likely to put unbearable pressure on the European Central Bank. This would threaten its ability to implement a stable and predictable monetary policy. Whereas the results

suggest that the EU-15 should not form a monetary union, there is a strong conviction that a subset of EU countries could do so [see also De Grauwe, 1996]. The mimimum set of countries that could form a monetary union is believed to include Germany, the Benelux countries and France.

The analysis of technology, growth and convergence consists of a descriptive statistical and an econometric analysis. In short, the descriptive statistical analysis confirms the impressions obtained from other empirical studies; that the EU is characterized empirically by economic convergence. However, the process of convergence has not been stable, either over time or across countries. The subsequent econometric analysis implies that, over the post World-War II period, European economies have been converging in terms of output per capita. Other things being equal, poor countries in Europe tend to grow faster than richer ones. Technological differences, however, are found to be an important factor for our understanding of growth and convergence in the European Union. The econometric analysis seems to support a model with technological diffusion, in which technologically lagging economies manage to catch-up to technological leaders by innovating and imitating at a lower cost. In addition, the exhaustion of catch-up opportunities, which is associated with initial technical backwardness, may be a factor that helps to explain the slowdown of growth and convergence in more recent years. With respect to the causes of the non-stable convergence processes in Europe over time and across countries, the econometric analysis does not give a conclusive answer, but rather points to several responsible factors. The distance of the economy to the technological leader differed across economies, which contributed to differences in convergence and growth behavior. In addition, the finding of conditional convergence implies that economies converge to different steady state levels of income per capita. Poor economies, like Portugal, Greece, Spain and Ireland presumably converge to lower steady state levels of income per capita, which leads to persistent differences in income per capita. It follows that investment efforts, from private or public sources, will be needed in peripheral countries to limit such disparities in the long-term. If we think of the responsibility of policymakers to reduce disparities in Europe, based on Article 130a of the Maastricht Treaty, the estimates may indicate that EU-wide fiscal transfers would be helpful to secure this goal. However, at the same time it needs to be emphasized that cohesion does not require that incomes or social conditions should be equalized. Nevertheless, if gaps are too large, it is clear that it will be difficult for the union to be cohesive. Plausible targets for reductions in disparities, which pass the test of being politically acceptable, would therefore be helpful [Begg and Mayes, 1993]. In order to reduce the foreseeable political and eco-

nomic tensions associated with prevailing real economic differences, the establishment of a stabilization scheme, as part of the union's federal budget could prove to be fruitful, even as a temporary agreement [Goodhart and Smith, 1993]. While fiscal transfer payments may contribute to reducing disparities, they do need to be handled with care with regard to the financial situation of the governments of member states.

5.2. Implications for European monetary integration

In addition to those policy proposals reviewed in chapter two, the following four policy implications may be formulated. The first refers to an operational policy interpretation of the Maastricht Treaty's convergence criteria, while the others refer to more long-term economic policy issues. The second policy implication stems from the empirical analysis of optimum currency areas in Chapter Three, where the possibility of creating currency blocks was indicated. The other policy implications are based on the observation that while the transition process will culminate in the adoption of a common currency by at least two countries in Europe by the end of the century, the convergence strategy will not contribute to macroeconomic stability in the future union. Therefore, with respect to the goal of achieving a successful and stable monetary union in the presence of structural differences it seems particularly relevant, first, to strengthen the monetary institutions in order to be even less vulnerable to political pressure and, second, to improve market transparency and information flows.

I. Broad interpretation of convergence criteria

An important issue on the transitional path to monetary union is how the convergence criteria determined in the Maastricht Treaty are to be applied. Three alternative transition strategies have emerged [Straubhaar and Schmidt, 1996]. The first strategy is to strictly adhere to the Maastricht Treaty's convergence criteria. The transition towards EMU follows gradually, although "as soon as possible". Only those countries which fulfill the monetary and fiscal convergence criteria are admitted into the third stage. However, hardly any country will be able to fulfill the convergence criteria if the numerology is taken seriously. "Realistically", at least, Germany and France should be members of EMU from the very beginning. In other words, by strict adherence to the convergence criteria either the number of countries would be sub-optimally low or the entry date would have to be postponed. Therefore, an alternative possibility is to postpone monetary union as a monetary union without a "critical mass" seems to be implausible. A multi-speed approach would reduce the advantages of participating

in the union for the member states. It may then make sense not to stick to the entry date and instead to wait until a larger number of countries will be able to enter into the third stage [Ohr, 1996]. However, postponement of monetary union may not be the answer, as it would further reduce the credibility of the monetary integration process. The third strategy is to interpret the existing convergence criteria in a wider sense. In principle, each country should be able to join monetary union as soon as it wants to do so. Each country may evaluate the costs and benefits of joining the union and decide if it is in its national interest to participate. However, according to Art. 109j, the "necessary preconditions" need to be taken into consideration. A broad interpretation is preferable to a strict adherence because some flexibility for the eventual participants is needed. Strict adherence would imply that only two countries will currently qualify, which is not a particularly realistic possibility. In this sense, a broad interpretation of the criteria is a political necessity in order to achieve monetary union. A broad interpretation is also more desirable than a postponement of the union, because the latter would imply high political costs in terms of credibility.

II. Monetary policy coordination among the nonparticipants

The gradual transition approach will probably lead to a multi-speed monetary union. If this is the case, the risk of splitting the European Union apart should be taken into consideration. As suggested in Chapter Three, one solution may be the creation of currency blocks in Europe. Those countries not initally eligible to enter the third stage might benefit from forming a seperate monetary union (or unions). The efficiency gains obtained from these currency blocks would enable the lagging countries to catch-up to those already in the third stage of monetary union.

III. Institutional strengthening

To strengthen the institutional arrangements of the EU, the implementation of incentive contracts is proposed. Incentive contracts are measures by which the central banker can be penalized for inflation [D.Romer, 1996]. Incentives are affected by such facets of institutional design as the appointment and reappointment procedures for members of the policy-making committee, the existence of reporting requirements, and the presence of legislated policy goals [Walsh, 1995]. Several concrete forms for the formulation of incentive contracts for the executive board of the ECB can be thought of. Firstly, the incomes of the members of the executive board of the European Central Bank might be made contingent on the state of the economy, thereby influencing the incentives the executive board faces in choosing the rate of inflation. Secondly, targeting rules might be enforced by making the ECB's budget depend on adherence to the rules [Rogoff,

1985]. Thirdly, an even stronger measure is to define a procedure for removal of the executive board of the ECB should it fail to maintain price stability. Whatever its concrete form, an incentive contract would make the future ECB more accountable. At the same time, it would be costly for the governors of the ECB to follow national political pressures and would thereby contribute to price stability even in the future union. The contract should contain an inflation targeting procedure, which many central banks already follow successfully and such a procedure would be useful within the ECB.

IV. Public debt management

A way to make policies more credible is to enforce a time-consistent public debt management scheme. One way to do this is to issue short-term maturity bonds. Short maturities reduce the government's incentive to produce surprise inflation and thereby contribute to solve the time-consistency problems of fiscal policies as discussed in Chapter Two. This increases the willingness of wealth owners to buy the debt and lowers the borrowing costs of the government [Missale and Blanchard, 1994; De Grauwe, 1996]. An alternative, or complementary, way is to issue inflation-indexed bonds; bonds whose interest payments and principal are tied to inflation. Inflation index-linked bonds have been used recently in Australia, Canada, New Zealand, and Great Britain. The United States has decided to introduce them in May 1996. In Britain, 57% of marketable debt in 1995 consisted of outstanding index-linked bonds [The Economist, 1996]. Index-linked bonds change a governments' incentives and so tend to make monetary policies more credible. When debt-service payments are denominated in nominal terms, higher than expected inflation rates lower the debt burden, whilst fully anticipated inflation does not lower the debt burden [Calvo, 1978; Persson and Tabellini, 1990]. By engineering these inflation surprises the government expects to cause a reduction in the real public debt burden, which allows a reduction in the tax rate whilst keeping the solvency constraint intact. In equilibrium, with rational private agents who take this information into account in forming their inflation expectations, the public will anticipate the inflation surprises and hence render them ineffective. As a consequence, the inflation rates will be relatively high in the long-run without a positive effect on the debt burden. In short, with nominal public debt, governments have an incentive to inflate debts away at the bondholders' expense. If payments of interest and principal increase with rising price levels, governments will be less tempted to let inflation rise. Index-linked bonds can help governments to estimate financial markets' expectations of inflation. This is useful for monetary policymaking, as a rise in the expected inflation rate may be a signal that policy should be tightened. Thereby,

the conduction of monetary policies could be improved. In addition, it would help to predict long-term interest rates as they contain inflation rate expectations and would thereby contribute to the more precise evaluation of risk. At the same time, index-linked bonds may contribute to a stabilization of the interest rate level as well as of the term structure, since interest rates on indexed bonds will supposedly approach the level of the real interest rate in the economy [Pilchner et.al., 1979]. In addition, index-linked bonds provide benefits in that they increase the supply of alternative financial instruments which leads to more competition and which enhances the utility of savers [Pilchner et.al., 1979]. In sum, inflation-indexed bonds would help markets to evaluate risk both by providing estimates of inflationary expectations and making monetary policies more credible by changing governments' incentives. While in Germany the Bundesbank Act (Gesetz über die Deutsche Bundesbank) rules out, in a strict adherence to the nominal value principle, the use of indexation as a policy instrument, the regulations of the European Central Bank does not preclude their use [Rebelo, 1994]. One might thus require the member states of the monetary union to issue inflation-indexed bonds. To obtain a self-balancing mechanism, high-debt countries may be required to issue a larger share of their outstanding government bonds in the form of inflation-indexed bonds than low-debt countries.

References

Abraham, F. and P. Von Rompuy (1995), "Regional convergence in the European Monetary Union", *Papers in Regional Science*, 74 (2), 125-142.

Abramovitz, M. (1979), "Rapid growth potential and its realization", in *Thinking About Growth and Other Essays on Economic Growth and Welfare*. Cambridge University Press, 1989, 187-219.

Abramovitz, M. (1986), "Catching-up, forging ahead, and falling behind", *Journal of Economic History*, 66, 385-406.

Alesina, A. and V.Grilli (1992), "The European Central Bank: reshaping monetary politics in Europe", in M.Canzoneri, V.Grilli and P.Masson (eds.): *Establishing a Central Bank: Issues in Europe and Lessons from the US*, Cambridge University Press.

Alesina, A. and V.Grilli (1993), "On the feasibility of a one or multi-speed European monetary union", *Economics and Politics*, 5 (2),145-165.

Alogoskoufis, G. (1992), "Monetary accomodation, exchange rate regimes and inflation persistence, *The Economic Journal*, 102, May=No.412, 461-480.

Alogoskoufis, G. (1994), "On inflation, unemployment, and the optimal exchange rate regime", in F.Van der Ploeg (ed.): *Handbook of International Economics*, 2, 193-223.

Amemiya, T. (1967), "A note on the estimation of Balestra-Norlove models", Technical Report No.4, Institute for Mathematical Studies in Social Sciences, Stanford University.

Andrés, J. and J. Boscá (1993), "Technological differences and convergence in OECD countries, Working Paper No. D-93005, Dirección General de Planificación, Ministerio de Economia y Hacienda.

Andrés, J. and A.R. Lamo (1994), "Dynamics of the income distribution across OECD countries", unpublished manuscript.

Andrés, J., J. E.Bosca and R. Domenech (1995), "Main patterns of economic growth in OECD countries", *Investigaciones Economicas*, 19 (1), 35-63.

Armstrong, H. W. (1995), "Convergence among regions of the European Union, 1950 - 1990", *Papers in Regional Science*, 74 (2), pp.143-152.

Artis, M. (1991), "One market, one money: an evaluation of the potential benefits and costs of forming an economic and monetary union", *Open Economies Review*, 2 (3), 315-321.

Artis, M. (1994a), "Stage Two: feasible transitions to EMU", CEPR Discussion Paper No.928.

Artis, M. (1994b), "European Monetary Union", in M. Artis (ed.): *The Economics of Monetary Union*, Oxford University Press.

Audretsch, D. and M.Feldman (1994), "Knowledge spillovers and the geography of innovation and production", CEPR Discussion Paper No. 953.

Azariadis, C. and A. Drazen (1990), "Threshold externalities in economic development", *Quarterly Journal of Economics*, 105 (3), 501-526.

Barro, R. J. (1991), "Economic growth in a cross-section of countries", *Quarterly Journal of Economics*, 106 (2), 407-433.

Barro, R. J. and D. B. Gordon (1983a), "A positive theory of monetary policy in a natural rate model", *Journal of Political Economy*, 91, 589-610.

Barro, R.J. and D.B. Gordon (1983b), "Rules, discretion and reputation in a model of monetary policy", *Journal of Monetary Economics*, 12, 101-122.

Barro, R.J. and X.Sala-i-Martin (1991), "Convergence across states and regions", *Brookings Papers on Economic Activity*, No.1, 107-182.

Barro, R.J. and X.Sala-i-Martin (1992), "Convergence", *Journal of Political Economy*, 100 (2), 223-251.

Barro, R.J. and X.Sala-i-Martin (1992), "Regional growth and migration: A Japan-United States comparison", *Journal of the Japanese and International Economics*, 6 (4), 312-346.

Barro, R.J. and X.Sala-i-Martin (1995a), *Economic growth*, McGraw-Hill.

Barro, R.J. and X.Sala-i-Martin (1995b), "Technological diffusion, convergence, and growth", NBER Working Paper No.5151.

Baumol, W.J. (1986), "Productivity growth , convergence and welfare", *American Economic Review*, 76 (5), 1138-1155.

Baumol, W.J., S.A.B. Blackman, and E.N. Wolff (1989), *Productivity and American Leadership: The long view*, MIT Press.

Bayoumi, T. and B. Eichengreen (1993), "Shocking aspects of European monetary unification", in F.Torres and F.Giavazzi (eds.), *Adjustment and Growth in the European Monetary Union*, Cambridge, Cambridge University Press.

Bayoumi, T. and B.Eichengreen (1994), "Restricting yourself: fiscal rules and stabilization", CEPR Discussion Paper No.1029.

Bayoumi, T. and E.Prasad (1995),"Currency unions, economic fluctuations and adjustment: some empirical evidence", CEPR Discussion Paper No.1172.

Bean, C. R. (1992), "Economic and monetary union in Europe", CEPR Discussion Paper No.722.

Begg, D., P. Chappori, F.Giavazzi, C.Mayer, D.Neven, L.Spaventa, X.Vives and C.Wyplosz (1991), *Monitoring European integration: The making of the monetary union*, CEPR Annual Report, 1-66.

Begg, Iain and Mayes, David (1993), "Cohesion in the European Community", *Regional Science and Urban Economics*, 23 (3), 427-448.

Ben-David, D. (1993), "Income disparity among countries and the effects of freer trade", Nota di Lavoro 37.93, Fondazione Eni Enrico Mattei.

Ben-David, D. (1994), "Convergence clubs and diverging economies", CEPR Discussion Paper No.922.

Ben-David, D. (1995), "Slowdowns and meltdowns: post-war growth evidence from 74 countries", CEPR Disc.Paper No.1111

Bernanke, B. (1986), "Alternative explanations of the money-income correlation", *Carnegie-Rochester Conference Series on Public Policy*, 25, 49-100.

Bernard, A.B. (1991), *Essays on cross-country output movements*, Ph.D. Dissertation, Stanford University.

Bernard, A.B. and Durlauf, S.N. (1996), "Interpreting tests of the convergence hypothesis", *Journal of Econometrics*, 71(1/2), 161-173.

Bernard, A.B. and Durlauf, S.N. (1995), "Convergence in International Output", *Journal of Applied Econometrics*, 10 (2), 97-108.

Bini-Smaghi, L., T.Padoa-Schioppa, and F.Papadia (1994), *The transition to EMU in the Maastricht Treaty*, Essays in International Finance, No.195, Princeton: International Finance Section, Princeton University Press.

Blackburn, K. and M. Christensen (1989), "Monetary policy and policy credibility: Theories and evidence", *Journal of Economic Literature*, 26, March, 1-45.

Blanchard, O.J. and L.F.Katz (1992), "Regional evolutions", *Brookings Papers on Economic Activity*, No.1, 1-75.

Blanchard, O.J. and D.Quah (1989), "The dynamic effects of aggregate demand and supply disturbances", *American Economic Review*, 79 (4), 655-673.

Blanchard, O.J. and M.Watson (1986), "Are business cycles all alike?", in R.J.Gordon (ed.) *The American Business Cycle: Continuity and Change*, University of Chicago Press.

Bovenberg, A.L., J.J. Kremers, and P.R. Masson (1991), "Economic and monetary union in Europe and constraints on national budgetary policies", *IMF Staff Papers*, 38 (2), 374-398.

Brezis, E., P.Krugman, and D.Tsiddon (1993), "Leapfrogging in international competition: A theory of cycles in national technological leadership", American Economic Review, 83 (5), 1211-1219.

Bruno, M. and J.D.Sachs (1985), *The economics of worldwide stagflation*, MIT Press.

Buiter, W.H. (1992), "Should we worry about the fiscal numerology of Maastricht?", CEPR Discussion Paper No.688.

Buiter, W.H. (1995), "Macroeconomic policy during a transition to monetary union", CEPR Discussion Paper No.1222.

Buiter, W. and K. Kletzer (1991), "Reflections on the fiscal implications of a common currency", in A. Giovannini and C. Mayer (eds.), *European Financial Integration.* Cambridge University Press.

Buiter, W., G.Corsetti and N.Roubini (1993), "Excessive deficits: sense and nonsense in the Maastricht Treaty", *Economic Policy,* 8, April=No.16, 57-100.

Calvo, Guillermo (1978), "On the time consistency of optimal policy in a monetary economy", *Econometrica*, 46, 1411-1428.

Cameron, G. (1996), "Innovation and economic growth", Discussion Paper No.277, Centre for Economic Performance.

Canova, F. and A.Marcet (1995), "The poor stay poor: non-convergence across countries and regions", CEPR Discussion Paper No.1265.

Carlino, G. and L. Mills (1993), "Testing Neoclassical convergence in regional incomes and earnings", Working Paper No.93-22, Federal Reserve Bank of Philadelphia.

Chamberlin, G. (1984), *Panel data*, Chapter 22 in Z.Griliches and M.D.Intriligator (eds.), Handbook of Econometrics, Volume II, Amsterdam: Elsevier Science Publishers.

Charemza, W.W. and D.F.Deadman (1992), *New directions in econometric practice*, Edward Elgar Publishing.

Cohen, D. and Wyplosz, C. (1989), "The European Monetary Union: An agnostic evaluation", in Ralph Bryant et.al. (eds.), *Macroeconomic Policies in an Interdependent World.* Washington D.C.: The International Monetary Fund.

Cohen, D. (1995), "Tests of the convergence hypothesis: Some further results", CEPR Discussion Paper No.1163.

Committee for the Study of Economic and Monetary Union (1989), Report on Economic and Monetary Union in the European Community, (cited her as The Delors Report). Luxembourg: Office for Official Publications of the European Communities.

Cooley, T.F. and S.F.LeRoy (1985), "A-theoretical macroeconomics", *Journal of Monetary Economics*, 16 (3), 283-308.

Coulombe S. and F.C.Lee (1995a), "Regional productivity convergence in Canada", *Canadian Journal of Regional Science*, 18 (1), 39-56.

Coulombe, S. and F.C.Lee (1995b), "Convergence across Canadian provinces: 1961 - 1991", Canadian Journal of Economics, 28 (4), 886-898.

Crafts, N.F.R. and T.C. Mills (1995), "Europe's golden age: an econometric investigation of changing trend rates of growth", CEPR Discussion Paper No.1087.

Crafts, N.F.R. and G.Toniolo (1995), "Post-war growth: an overview", CEPR Disc.Paper No.1095.

Crowley, Patrick M. (1996), "EMU, Maastricht, and the 1996 intergovernmental conference", *Contemporary Economic Policy*, 14 (2), 41-55.

Cumby, R.E. and M.Obstfeld (1984), "International interest rate and price level linkages under flexible exchange rates: A review of recent evidence", in J.Bilson and R.Marston (eds.): *Exchange Rate Theory and Practice*. University of Chicago Press.

Decressin, J. and A. Fatás (1995), "Regional labour market dynamics in Europe", *European Economic Review*, 39.

De Grauwe, P. (1989), "Fiscal discipline in monetary unions", International Economics Research Papers, No.71, Katholieke Universiteit Leuven.

De Grauwe, P. (1993), "The political economy of monetary union", CEPR Discussion Paper No. 842.

De Grauwe, P. (1994a), *The economics of monetary integration*, Oxford University Press.

De Grauwe, P. (1994b), "Towards monetary union without the EMS", *Economic Policy*, 9, April=18, 148-185.

De Grauwe, P. (1995), "Monetary union and convergence economics", Paper presented at the Tenth Annual Congress of the European Economic Association, Prague, September.

De Grauwe, P. (1996), "The economics of convergence: towards monetary union in Europe", *Weltwirtschaftliches Archiv*, 132 (1), 1-27.

De Grauwe, P. and Gros, D. (1991), "Convergence and divergence in the Community's economy on the eve of Economic and Monetary Union", in Peter Ludlow (ed.) *Setting EC Priorities*, Brussels and CEPS, London.

De Grauwe, P. and H. Heens (1993), "Real exchange rate variability in monetary unions", *Recherches Economiques de Louvain*, 59 (1-2), 105-117.

De la Fuente, A. (1995a), " The empirics of growth and convergence: a selective review", Working Paper WP 294.95, Institut d'Anàlisi Econòmica, Barcelona.

De la Fuente, A. (1995b), "Catch-up, growth and convergence in the OECD", paper presented at the meeting of the EEA, Prague, September.

De Long, B. J. (1988), "Productivity growth, convergence and welfare: a comment", *American Economic Review*, 78 (5), 1155-1159.

De Long, J.B. and L.Summers (1992), "Macroeconomic policy and long-run growth", in: *Policies for long-run growth*, Symposium Series, Federal Reserve Bank of Kansas City.

Desdoigts, Alain (1994), *Changes in the world income distribution: A non-parametric approach to challenge the neoclassical convergence argument*, Ph.D. Thesis, European University Insitute, Florence.

Di Liberto, A. (1994), "Convergence across Italian regions", Nota di Lavoro 68.94, Fondazione Eni Enrico Mattei.

Doan, T.A. (1992), *RATS User's Manual*, Version 4.02, ESTIMA Ltd.

Dolado, J.J., J.M.Gonzalez-Paramo and J.M.Roldan (1994), "Convergencia económica entre las provincias Espanolas: evidencia empírica (1955-1989)", Documento de Trabajo No. 9406, Banco de Espana - Servicio de Estudios.

Dollar, D. and E.N.Wolff (1988), "Convergence of industry labor productivity among advanced economies, 1963-82", *Review of Economics and Statistics*, 70, 549-558.

Dornbusch, R. (1990), "Two-track EMU, now!", in: Pohl et.al. (eds.): Britain and EMU, Centre for Economic Performance, London.

Dowrick, S. (1992), "Technological catch up and diverging incomes: patterns of economic growth", *The Economic Journal*, 102, 600-610.

Dowrick, S. and D.T. Nguyen (1989), "OECD comparative economic growth 1950-1985: catch-up and convergence", *American Economic Review*, 79 (5) (December), 1010-1030.

Dowrick, S. and N.Gemmell (1991), "Industrialisation, catching up and economic growth: a comparative study across the world's capitalist economies", *The Economic Journal*, 101, March=No.405, 263-275.

Durlauf, S.N. and P.Johnson (1992), "Local versus global convergence across national economies", LSE Financial Markets Group Discussion Paper No.131.

Easterlin, R.A. (1981), "Why isn't the whole world developed?", *Journal of Economic History*, 41 (1), 1-19.

Eaton, J. and S.Kortun (1995), "Engines of growth: domestic and foreign sources of innovation", NBER Working Paper No.5207.

Edwards, S. (1993), "Exchange rates as nominal anchors", NBER Working Paper No.4346.

Eichengreen, B. (1992a), *Should the Maastricht Treaty be saved?*, Princeton Studies in International Finance No.74, Princeton: International Finance Section, Princeton University.

Eichengreen, B. (1992b), "Is Europe an optimum currency area?", in: S.Borner and H.Grubel (eds.): *The European Community after 1992*, Basingstroke, 138-161.

Eichengreen, B. (1993), "European monetary unification and regional unemployment", in: B.Eichengreen et.al. (eds.): *Labor and an integrated Europe*, Brookings Institution, Washington.

Eichengreen, B. (1994), *International monetary arrangements for the 21st century*, Brookings Studies on Integrating National Economies, Washington: The Brookings Institution.

Eichengreen, B. and J.Frieden (1993), "The political economy of European monetary unification: An analytical introduction", *Economics and Politics*, 5 (2), 85-104.

Eichengreen, B. and C.Wyplosz (1993), "The unstable EMS", CEPR Discussion Paper No.817.

Eichengreen, B. and F. Ghironi (1995), "European monetary unification: the challenges ahead", CEPR Discussion Paper No.1217.

Eichengreen B. and J. Von Hagen (1995), "Fiscal policy and monetary union: federalism, fiscal restrictions and the no-bailout rule", CEPR Discussion Paper No.1247.

Eichengreen, B. and J. Von Hagen (1995), "Fiscal policy and monetary union: Is there a tradeoff between federalism and budgetary restrictions", NBER Working Paper No.5517.

Emerson, M., D.Gros, A.Italianer, J.Pisani-Ferry, and H.Reichenbach, *One Market, One Money*, Oxford University Press.

Engle, R.F. and C.W.J.Granger (1987), "Cointegration and error-correction. Representation, estimation, testing.", *Econometrica*, 251-276.

Erkel-Rousse, H. and J.Mélitz: New empirical evidence on the costs of European monetary union, CEPR Discussion Paper No. 1169, May 1995

Ethier, W.J. (1982), "National and international returns to scale in modern theory of international trade", *American Economic Review*, 72 (2), 389-405.

European Monetary Institute (1995), *Progress towards convergence*, November.

Evans, G.W. (1989), "Output and unemployment dynamics in the United States: 1950-1985", *Journal of Applied Econometrics*, 4 (3), 213-237.

Fischer, P. and T.Straubhaar (1995), "Migration and economic integration in the Nordic common labour market". Anniversary issue: *40 years of the Nordic common labour market*, Nordic Council of Ministers.

Fischer, S. (1977), "Long-term contracts, rational expectations, and the optimum supply rule", *Journal of Political Economy*, 85 (1), 191-205.

Flood, R.P. and P.M.Garber (1984), "Collapsing exchange-rate regimes: Some linear examples", *Journal of International Economics*, 17.

Franz, W. (1991), *Arbeitsmarktökonomik*, Springer-Verlag.

Fratianni, M. and J.Von Hagen (1992), *The European Monetary System and European Monetary Union*, Boulder, Colorado: Westview Press.

Fratianni, M. J.Von Hagen, and C.Waller (1992), *The Maastricht Way to EMU*, Essays in International Finance, No.187, Princeton: International Finance Section, Princeton University.

Fratianni, M. and H.Huang (1995), "New growth theory: A survey from a policy perspective", Kredit und Kapital, 28 (1), 62-86.

Frenkel, J.A. and M.Goldstein (1991), Monetary policy in an emerging European economic and monetary union", *IMF Staff Papers*, 38 (2), 356-373.

Friedman, M. (1974), Monetary correction, in *Essays on Inflation and Indexation*, 25-61.

Friedman, M. (1992), "Do old fallacies ever die?", *Journal of Economic Literature*, 30(4), 2129-2132.

Froot, K.A. and K.Rogoff (1991), "The EMS, the EMU, and the transition to a common currency", NBER Working Paper No.3684.

Funke, M. (1994), "How important are demand and supply shocks in explaining German business cycles? New evidence on an old debate", Centre for Economic Forecasting, Discussion Paper No.17-94, London Business School.

Funke, M. (1995), "Europe's monetary future: one market, one money?", Discussion Paper 1-95, Centre for Economic Forecasting, London Business School.

Fuller, W.A. (1976), *Introduction to time series*, New York: John Wiley.

Galí, J. (1993), "How well does the IS-LM model fit postwar U.S. data?", *Quarterly Journal of Economics*, 107(2), 709-738.

Galí, J. and J.Hammour (1991), "Long-run effects of business cycles", CV Starr Working Paper.

Genberg, H. and A.Swoboda (1985), *External influences on the Swiss economy under fixed and flexible exchange rates*, Verlag Rüegger.

Gerschenkron, A. (1952), "Economic backwardness in historical perspective", in Hoselitz, B.F. (ed.), *The Progress of underdeveloped areas*, Chicago University Press.

Giannini, C. (1992), *Topics in structural VAR econometrics*, in M.Beckmann and W.Krelle (eds.): Lecture Notes in Economics and Mathematical Systems, Springer-Verlag.

Giavazzi, F. and M. Pagano (1988), "The advantage of tying one's hands. EMS discipline and central bank credibility", *European Economic Review*, 32 (4), 1055-1077.

Giavazzi, F. and A. Giovannini (1989) *Limiting exchange rate flexibility: The European Monetary System*, MIT Press.

Giersch, H. (1974), Index clauses and the fight against inflation, in *Essays on inflation and indexation*, 1-23.

Giovannini, A. (1990a), "European monetary reform: progress and prospects", *Brookings Papers on Economic Activity*, No.2.

Giovannini, A. (1990b), *The transition to European monetary union*, Essays in International Finance, No.178, Princeton: International Finance Section, Princeton University.

Giovannini, A. and L.Spaventa (1991), "Fiscal rules in the European monetary union: A no-entry clause", CEPR Discussion Paper No.516.

Goldman Sachs (1995),"Real criteria for EMU", *The UK Economics Analyst*, 10 (3/4), March / April

Goldstein, M. and G.Woglom (1992), "Marked-based fiscal discipline in monetary unions", in M.Canzoneri, V.Grilli, and P.Masson (eds.), *Establishing a Central Bank: Issues in Europe and Lessons from the US*, Cambridge University Press.

Gould, D.M. and R.J. Ruffin (1994), "Human capital, trade, and economic growth", *Weltwirtschaftliches Archiv*, 131 (3), 425-445.

Grahl, J. and J.Simms (1993), "Endogenous growth in the European regions", in *The Location of Economic Activity: New theories and evidence*, CEPR, 389-414.

Granger, C.W.J. (1969), "Investigating causal relations by econometric models and cross-spectral methods", *Journal of Econometrics*, 39, 143-159.

Granger, C.W.J. (1988), "Some recent developments in a concept of causality", *Journal of Econometrics*, 39 (1/2), 199-211.

Granger, C.W.J. and P.Newbold (1986), *Forecasting economic time series*, 2nd edition, Academic Press.

Griliches, Z. (1988), "Productivity puzzles and R&D: Another non-explanation", *Journal of Economic Perspectives*, 2, 9-21.

Gros, D. (1989), "Seigniorage in the EC: The implications of the EMS and financial market integration", IMF Working Paper WP/89/7.

Gros, D. and G.Vandille (1992), "Seigniorage and EMU: The fiscal implications of price stability and financial market integration", CEPS Working Documuent, No.69.

Gros, D. (1995), "Towards a credible excessive deficits procedure", Centre for European Policy Studies, April.

Gros, D. and N.Thygesen (1992), *European monetary integration*, New York: St.Martin's.

Grossman, G. and E. Helpman (1991), *Innovation and growth in the global economy*, MIT Press.

Hagen, J.Von and G. Hammond (1995), " Regional insurance against asymmetric shocks: an empirical study for the European Community", CEPR Discussion Paper No.1170.

Hall, S., D. Richardson and M. Wickens (1993), "How to measure convergence with an application to the EC economies", Discussion Paper No.79-93, Centre for Economic Forecasting, London Business School

Hall, S., D. Richardson and M. Wickens (1992), "Measuring convergence of the EC economies", Discussion Paper No.01-92, Centre for Economic Forecasting, London Business School.

Hansen, G. (1993), *Quantitative Wirtschaftsforschung*, Verlag Vahlen.

Hansson, P. and M. Henrekson (1994a), "Catching-up, social capability, government size and economic growth", Discussion Paper No.123, Trade Union Institute for Economic Research.

Hansson, P. and M. Henrekson (1994b), "What makes a country socially capable of catching up?", *Weltwirtschaftliches Archiv*, 130 (4), 760-783

Hart, P. E. (1994), "Galtonian regression across countries and the convergence of productivity", Discussion Paper No.19, University of Reading, March.

Harvey, A.C. and A.Jaeger (1993), "Detrending, stylized facts and the business cycle", *Journal of Applied Econometrics*, 8 (3), 231-247.

Hasse, R.H. (1992a), "Budget policies for a European monetary union: no laissez-faire but what kind of rules?", Discussion Paper No.20, Universität der Bundeswehr Hamburg.

Hasse, R.H. (1992b), *The European Central Bank: perspectives for a further development of the European Monetary System,* Bertelsmann Foundation Publication: Strategies and options for the future of Europe: basic findings.

Hasse, R.H. (1995a), "Analysis of the convergence criteria in the Maastricht Treaty. Are they able to create credibility?", in.:D.Currie and J.D. Whitley (eds.): *EMU after Maastricht*, London.

Hasse, R.H. (1995b), "Europäische Währungsunion im Spannungsfeld zwischen politischem Wunsch und ökonomischer Realität" Discussion Paper No.51, Universität der Bundeswehr Hamburg.

Hasse, R.H. (1996), "Maastricht: Die Haushaltspolitik als Prüfstein der währungspolitischen Integration", Discussion Paper No.61, Universität der Bundeswehr Hamburg.

Hedrich, C.-Ch. (1994), "Die Kritik an den Maastrichter Beschlüssen über die Europäische Währungsunion: Rechtliche und ökonomische Argumente", *Jahrbuch für Sozialwissenschaft*, 45, 68-91.

Helliwell, J. and A.Chung (1992), "Convergence and growth linkages between north and south", NBER Working Paper No.3948.

Herz, B. and W. Röger (1995), "Economic growth and convergence in Germany", *Weltwirtschaftliches Archiv*, 131 (1), 132-143.

Heylen, F. and A.Van Poeck (1995), "National labour market institutions and the European economic and monetary integration process", *Journal of Common Market Studies*, 33 (4), 572-595.

Heylen, F., A.Van Poeck, and J. Von Gompel (1995), "Real versus nominal convergence: national labour markets and the European integration process", *Labour*, 9 (1), 97 - 119.

Holtz-Eakin, D. (1992), "Solow and the states: capital accumulation, productivity and economic growth", NBER Working Paper No.4144.

Hsiao, C. (1986), *Analysis of panel data*, Cambridge University Press.

Hughes-Hallett, A. and A.Scott (1992), "The fiscal policy dilemmas of monetary union", in P.Coffey (ed.), *Main Economic Policy Areas of the EC-After 1992*, Kluwer Academic Publishers, 65-105.

Ishiyama, Y. (1975), "The theory of optimum currency areas: A survey", *IMF Staff Papers*, 22, 344-383.

Islam, N. (1992), "Small sample properties of dynamic panel data estimators: A Monte Carlo study", Department of Economics, Harvard University.

Islam, N. (1995), "Growth empirics: A panel data approach", *Quarterly Journal of Economics*, 105 (4), 1127 - 1170.

Issing, Otmar (1992), "Perspektiven der Europäischen Währungsunion", in Deutsche Bundesbank (ed.), *Auszüge aus Presseartikeln* No.18, 06.03.1992, 1-6.

Italianer, A. (1993), "Mastering Maastricht: EMU issues and how they were settled," in H. Gretschmann (ed.) *Economic and Monetary Union: Implications for National Policy-Makers*, Amsterdam: European Institute of Public Administration.

Italianer, A. and J.Pisani-Ferry (1994), "The regional-stabilization properties of fiscal arrangements", in Mortensen, (ed.), *Improving Economic and Social Cohesion in the European Community*, London: Macmillan.

Jaffe, A., Trajtenberg, M. and R.Henderson (1993), "Geographic localization of knowledge spillovers as evidenced by patent citations", *Quarterly Journal of Economics*, 108 (3), 577-598.

Johansen, S. (1988), "Statistical analysis of cointegration vectors", *Journal of Economic Dynamics and Control*, 12 (2/3), 231-254.

Johansen, S. and K.Juselius (1990), "Maximum likelihood estimation and inference on cointegration - with application to the demand for money", *Oxford Bulletin of Economics and Statistics*, 52 (2), 169-210.

Jones, C.I. (1995), "Time series tests of endogenous growth models", *Quarterly Journal of Economics*, 110 (2), 495 - 525.

Jordan, T.J. (1994), "Reale Wechselkurse innerhalb der Schweiz und ausgewählter Nachbarstaaten", *Kredit und Kapital*, 27 (4),.518-535.

Journal of Economic Perspectives (1994), "Symposium on growth theory", with papers by P.Romer, G.Grossman and E.Helpman, R.M.Solow and H.Pack; (Winter), 8 (1).

Keller, W. (1993), "Cach-up and convergence in the Federal Republic of Germany: German regions, 1950-1989", mimeographed, Yale University.

Keller, W. (1995), *Technological change: Identification, theory and evidence*, Ph.D. Dissertation, Yale University, November.

Kenen, P.B. (1992), *EMU after Maastricht*, Washington: Group of Thirty.

Kenen, P.B. (1995), *Economic and Monetary Union in Europe*, Oxford University Press.

Klein, M. and M.J. Neumann (1990), "Seigniorage: what is it and who gets it?", *Weltwirtschaftliches Archiv*, 126 (2), 205-221.

Kloek, T. and H.K.Van Dijk (1978), "Bayesian estimates of equation system parameters: an application of integration by Monte Carlo", *Econometrica*, 46, 1-20.

Knight, M., N.Loayza and D.Villanueva (1992), "Testing the neoclassical theory of economic growth: A panel-data approach", *IMF Staff Papers* ,40 (3), 512-537.

Kortz, H. (1996a), "Der Termin des 1.1.1999 - Eine bloße Zielvorgabe für den Beginn der Endstufe der Europäischen Wirtschafts- und Währungsunion", forthcoming in: *Europarecht*.

Kortz, H. (1996b), *Die Entscheidung über den Übergang in die Endstufe der Wirtschafts- und Währungsunion*, Nomos-Verlag, Baden-Baden.

Krugman, P. (1979), "A model of balance-of-payments crises", *Journal of Money, Credit and Banking*, 11, 311-325.

Krugman, P. (1991), "History versus expectations", *Quarterly Journal of Economics*, 106, 651-667.

Krugman, P. (1993), "Lessons of Massachusetts for EMU", in F.Torres and F.Giavazzi (eds.), *Adjustment and growth in the European Monetary Union*, Cambridge University Press.

Krugman, P. and A.J. Venables (1995), "Globalization and the inequality of nations", NBER Working Paper No.5908.

Kydland, F. and E.Prescott (1977), "Rules rather than discretion: the inconsistency of optimal plans", *Journal of Political Economy*, 85, 473-490.

Landau, D. (1983), "Government expenditure and economic growth: a cross-country study", *Southern Economic Journal*, 49 (4), 783-792.

Landau, D. (1986), "Government and economic growth in the less developed countries: an empirical study for 1960-1980", *Economic Development and Cultural Change*, 35 (October), 35-75.

Langfeldt, E. (1992), "European monetary union: design and implementation", in R.Barrell (ed.), *Economic Convergence and Monetary Union in Europe*, London: Sage for the Association for the Monetary Union of Europe and the National Institute of Economic and Social Research.

Larch, M. (1994), "Regional cross-section growth dynamics in the European Community", Working Paper, European Institute, LSE, London.

Lehment, H. (1994), "Speculative pressure in the EMS: the role of capacity-related exchange rate expectations", Kiel Working Paper No.627, The Kiel Institute of World Economics.

Lehment, H. and J. Scheide (1992), "Die Europäische Wirtschafts- und Währungsunion: Probleme des Übergangs", *Die Weltwirtschaft*, Heft 1, 50-67.

Lesch, Hagen (1993), *Konvergenzkriterien einer Europäischen Währungsunion: Zur Logik der Bestimmungen von Maastricht*, Institut "Finanzen und Steuern" e.V., Nr.137.

Levine, R. and Renelt, D. (1991), "Cross- country studies of growth and policy: Some methodological, conceptual, and statistical problems", World Bank Working Paper Series No.608.

Levine, R. and Renelt, D. (1992), "A sensitivity analysis of cross-country growth regressions", *American Economic Review*, 82 (4),.942-963.

Lichtenberg, F. (1994), "Tests of the convergence hypothesis", *The Review of Economics and Statistics*, LXXVI (3), 576-579.

Lindberg, H., P. Söderling and L.E.O. Svensson (1993), "Devaluation expectations: The Swedish krona 1982 - 1992", *The Economic Journal*, 103, September=No.420, 1170-1179.

Lucas, R.J. (1976), "Econometric policy evaluation: A critique", *Carnegie Rochester Conference Series on Public Policy*, 19-46.

Lucas, R.J. (1988), "On the mechanics of economic development", *Journal of Monetary Economics*, 22 (1),.3-42.

Lucas, R.J. (1993), "Making a miracle", *Econometrica*, 61 (2), 251-272.

Lütkepohl, H. (1991), *Introduction to multiple time series analysis*, Springer-Verlag, New York.

Maddala, G.S. (1992), *Introduction to econometrics*, Macmillan.

Maddison, A. (1982), *Phases of capitalist development*, Oxford University press.

Maddison, A. (1991), *Dynamic forces in capitalist development*, Oxford University Press.

Mankiw, G., D. Romer and D.Weil (1992), "A contribution to the empirics of economic growth", *Quarterly Journal of Economics*, 107 (2), 503-530.

Masson, P.R. and M.P.Taylor (1992), "Issues in the operations of monetary unions and common currency areas", in M.Goldstein et.al. (eds.), *Policy issues in the Evolving International Monetary System*, Washington: International Monetary Fund, Occasional Paper No.96.

McKinnon, R.I. (1963), "Optimal Currency Areas", *American Economic Review*, 53, September, 717-725

Meese, R.A. and K.Rogoff (1983), "Empirical exchange rate models of the seventies: do they fit out of sample?", Journal of International Economics, 14, 3-24.

Minford, P. (1993), "Discussion of Bayoumi and Eichengreen", in F.Torres and F.Giavazzi (eds.), *Adjustment and Growth in the European Monetary Union*, Cambridge: Cambridge University Press.

Missale, A. and O.J.Blanchard (1994), "The debt burden and debt maturity", *American Economic Review*, 84 (1),.309-319.

Mittendorfer, R. (1994), "Juristisch-nationalökonomische Anmerkungen zu den Konvergenzkriterien von Maastricht", *Wirtschaftspolitische Blätter*, 5-6, 540-550.

Monticelli, C. and J. Vinals (1993), "European monetary policy in stage three: what are the issues?", in A.Giovannini, F.Guitian and R.Portes (eds.), *The Monetary Future of Europe*, London: Centre for Economic Policy Research.

Mundell, R.A. (1961), "Optimum currency areas", *American Economic Review*, 51, November, 609-617.

Mussa, M. (1991), "Monetary and fiscal policy in an economically unified Europe", *Carnegie-Rochester Conference Series on Public Policy*, 35, 223-260.

Myrdal, G. (1957), *Economic theory and underdeveloped regions*, London.

Nelson, R. R. and E.S.Phelps (1966), "Investment in humans, technological diffusion, and economic growth", *American Economic Review*, 56, 1,.69-75.

Neumann, M.J.M. (1992), "In die Ära der Euro-Mark", *Frankfurter Allgmeine Zeitung*, Nr.97, April 25, p.14.

Neven, D. and C.Gouyette (1994), "Regional convergence in the European Community", CEPR Discussion Paper No.914.

Nicolaysen, G. (1993), *Rechtsfragen der Währungsunion*. Schriftenreihe der Juristischen Gesellschaft zu Berlin, Heft 132, Berlin/New York.

Obstfeld, M. (1986), "Rational and self-fulfilling balance of payments crises", *American Economic Review*, 76 (1), 72-81.

OECD (1995), National Accounts, Main Aggregates Volume 1, 1960-1994.

OECD (1995), Labour Force Statistics, 1973-1993, Paris.

OECD (1995) Quarterly Labour Force Statistics, Number 3.

OECD, Main Economic Indicators, various issues.

OECD (195), Economic Outlook, December.

Ohr, R. (1993), "Die ökonomische Kritik am Vertrag von Maastricht", *Wirtschaftspolitische Blätter*, 40 (1), 27-37.

Ohr, R. (1996), "Eine Alternative zum Maastricht-Fahrplan", *Wirtschaftsdienst*, 76 (1), 24-30.

Osterwald-Lenum, M. (1992), "Recalculated and extended tables of the asymptotic distribution of some important maximum likelihood cointegration test statistics", *Oxford Bulletin of Economics and Statistics*, 54 (3), 461-471.

Pagano, P. (1994), "On productivity convergence in the EC countries", *Giornale degli Economisti e annali de economia*, Anno 52 (7/), 389-401.

Persson, T. and G. Tabellini (1990), "Macroeconomic policy, credibility and politics", in Jaques Lesourne and Hugo Sonnenschein (eds.): *Fundamentals of Pure and Applied Economics*, Vol.38, Harwood Academic Publishers, Chur.

Perroux, F. (1959), "Les forms de concurrence dans le marché commun", *Revue d'Economie Politique*.

Petschnigg, R. (1993), "Die Konvergenzkriterien des Unionsvertrages", *Wirtschaftspolitische Blätter* 1, 43-51.

Pfleiderer, O. (1974), "Indexierung im langfristigen Kapitalverkehr als Hilfsmittel der Inflationsbekämpfung", in Ehrlicher, W. (ed.): Probleme der Indexbindung, Beihefte zu Kredit und Kapital, Heft 2, 41-55.

Pilchner, J.H., H.Verhonig, and N.Hentschel (1979), *Inflation und indexierung: Theoretische Analyse, Instrumentarium, empirische Befunde und Kritik*, Volkswirtschaftliche Schriften Heft 290, Duncker & Humblodt, Berlin.

Poloz, S. S. (1990), "Real exchange rate adjustment between regions in a common currency area", Working Paper, Bank of Canada.

Quah, D. (1993a), "Empirical cross-section dynamics in economic growth", *European Economic Review*, 37(2/3), 426-434.

Quah, D. (1993b), "Galton's Fallacy and tests of the convergence hypothesis", *The Scandinavian Journal of Economics*, 95(4), 427-443.

Quah, D. (1994a), "Exploiting cross-section variation for unit-root inference in dynamic data", *Economics Letters*, 44(1), 9-19.

Quah, D. (1994b), "Ideas determining convergence clubs", LSE Working Paper.

Quah, D. (1994c), "Convergence empirics across economies with (some) capital mobility", London School of Economics, Centre of Economic Performance Working Paper No.567.

Quah, D. (1996), "Regional convergence clusters across Europe", Discussion Paper No.274, Centre for Economic Performance, London.

Rivera-Batiz, L. A. and P.M.Romer (1991), "Economic integration and endogenous growth", *Quarterly Journal of Economics*, 106 (2), 531-555.

Rogoff, K. (1985), "The optimal degree of commitment to an intermediate monetary target", *Quarterly Journal of Economics*, 100 (November), 1169-1189.

Romer, D. (1996), *Advanced Macroeconomics*, Mc Graw-Hill.

Romer, P.M.(1986), "Increasing returns and long-run growth", *Journal of Political Economy*, 94 (5), 1002-1037.

Romer, P.M. (1987a), "Crazy explanations for the productivity slowdown", in *NBER Macroeconomics Annual 1987* (ed.) Stanley Fischer, MIT Press.

Romer, P.M. (1987b), "Growth based on increasing returns due to specialization", *American Economic Review*, 77 (2), 56-62.

Romer, P.M. (1990), "Endogenous technological change", *Journal of Political Economy*, 98, 5 (October), part II, S71-S102.

Romer, P.M. (1994), "The origins of endogenous growth", *Journal of Economic Perspectives*, 8(1), 3-22.

Romer, P.M. (1995), "Comment", *Brookings Papers on Economic Activity*, No.1.

Rose, A.K. and L.E.O.Svensson (1993), "Assessing target zone credibility: mean reversion and devaluation expectations in the ERM, 1979 - 1992", *European Economic Review*, 37, 763-802.

Sachs, J. and X.Sala-i-Martin (1992), "Fiscal federalism and optimum currency areas: evidence for Europe from the United States", in M.Canzoneri, V.Grilli and P.Masson (eds.), *The European Monetary System*, Cambridge: Cambridge University Press.

Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung (1995): Jahresgutachten 1995/96 (Im Standortwettbewerb). Drucksache 13/3016 des Deutschen Bundestags vom 15.11.1995.

Sala-i-Martin, X. (1990), "Lecture notes of Economic growth: introduction to the literature and Neoclassical models (Volume I), Five prototype models of endogenous growth (Volume II)", Center Discussion Paper Nos. 621 & 622.

Sala-I-Martin, X. (1995), "Regional cohesion: evidence and theories of regional growth and convergence", CEPR Discussion Paper No. 1075.

Sala-i-Martin, X. (1995), "The classical approach to convergence analysis", CEPR Discussion Paper No. 1254.

Sargent, T. (1979), "Estimating vector autoregressions using methods not based on explicit economic theories", *Quarterly Review*, Federal Reserve Bank of Minneapolis.

Scharrer, H.E. (1995a), "Eine Verschiebung löst keine Probleme", *Wirtschaftsdienst*, 75 (11), 589-591.

Scharrer, H.E. (1995b), "Monetary postponement is no answer", *Intereconomics*, 30, 265-266.

Scheide, J. and P. Trapp (1991), "Erfordert eine europäische Währungunion die Harmonisierung der Finanzpolitik?, in: Jürgen Siebke (ed.): *Monetäre Konfliktfelder der Weltwirtschaft*, in: Schriften des Vereins für Socialpolitik, N.F.Bd.210, pp.429-446.

Schmidt, C. (1996), "Technology, convergence, and growth in the European Union", *International Advances in Economic Research*, 2(3), 255-269.

Schmidt, C. and T.Straubhaar (1995a), "Maastricht II: Are real convergence criteria needed?", *Intereconomics*, 30 (5), 211-220.

Schmidt, C. and T. Straubhaar (1995b), "Maastricht II: Bedarf es realer Konvergenzkriterien?", *Wirtschaftsdienst*,75 (8), 434-442.

Shaw, G.K. (1992), "Policy implications of endogenous growth theory", *The Economic Journal*, 102 , No.412, 611-621.

Siebert, H. (1997), "Stabilitätspakt - Die Geldpolitik in der Währungsunion ent-politisieren", *Wirtschaftsdienst*, 77 (1), 7-10.

Sims, C.A. (1980), "Macroeconomics and reality", *Econometrica*, 48, 1-49.

Solow, R. (1956), "A contribution to the theory of economic growth", *Quarterly Journal of Economics*, 70 (1), 65-94.

Straubhaar, T. and C. Schmidt (1996), "Der Weg zur Europäischen Währungsunion zwischen ökonomischer Kritik, rechtlicher Verbindlichkeit und politischer Realität", in: Werner Zohlnhöfer (ed.): *Probleme und Reformbedarf der Europäischen Wirtschafts- und Währungsunion*. Berlin (Duncker & Humboldt).

Summers, R. and A. Heston (1991), "The Penn World Table (Mark 5): An expanded set of international comparisons, 1950-1988", *Quarterly Journal of Economics*, 106 (2), 327-368.

Stern, N. (1991), "The determinants of growth", *The Economic Journal*, 101 (1), 122-133.

Svensson, L.E.O: (1994),"Fixed exchange rates as a means to price stability: What have we learned?", NBER Working Paper No.4504.

Tavlas, G.S. (1993), "The new theory of optimum currrency areas", *The World Economy*, 16 (6), 663-685.

Tavlas, G.S. (1994), "The theory of monetary integration", *Open economies review*, 5(2), 211-230.

THE ECONOMIST (1996), "Of beef, bushels and bonds", May 25th, p.94.

Tichy, G. (1994), *Konjunktur: Stilisierte Fakten, Theorie, Prognose*, Springer-Verlag.

Thomas, I. (1995), "Konvergenz und Divergenz in der Europäischen Union - Theoretischer Überblick, empirische Evidenz und wirtschaftspolitische Implikationen", Kieler Arbeitspapier Nr.682.

Throop, A.W. (1994), "International financial market integration and linkages of national interest rates", Economic Review, Federal Reserve Bank of San Francisco, Number 3, 1-16.

Thygesen, N. (1993a), "Towards monetary union in Europe - Reforms of the EMS in the perspective of monetary union", *Journal of Common Market Studies*, 31 (4).

Thygesen, N. (1993b), "Economic and monetary union: critical notes on the Maastricht Treaty revisions", in F.Torres and F.Giavazzi (eds.): *Adjustment and Growth in the EMU*.

Tower, E. and T.Willett (1976), *The theory of optimum currency areas and exchange rate flexibility*, Special Papers in International Finance, No.11. Princeton University Press.

Uebe, G. and Fischer, J. (1992), *Macroeconometric models*, 2nd edition, Avebury Press.

Van der Ploeg, F. (1991), Budgetary aspects of economic and monetary integration in Europe", CEPR Discussion Paper No.492, London: Centre for Economic Policy Research.

Vaubel, R. (1997), "Kein Pakt für Preisstabilität", *Wirtschaftsdienst*, 77 (1), 10-12.

Verspagen, B. (1991), "A new empirical approach to catching up and falling behind", *Structural change and economic dynamics*, 2 (2), 359-380.

Vinals, J. (1994), "Building a monetary union in Europe: Is it worthwile, where do we stand, and where are we going?", CEPR Occasional Paper No.15.

Vinals, J. (1996), "European monetary integration: A narrow or a wide EMU", European Economic Review, 40 (3-7), 1103-1110.

Von Rompuy, P., Abraham, F., and Heremans, D. (1990) "Economic federalism and the EMU", International Economics Research Paper No.69, Katholieke Universiteit Leuven.

Wagner, H. (1995), "The EMU-debate in the light of modern macroeconomics", in Flemming, J. (ed.): *Moderne Makroökonomik: Eine kritische Bestandsaufnahme*. Marburg, 455-481.

Walsh, C.E. (1995), "Optimal contracts for central bankers", *American Economic Review*, 85 (1), 150-165.

Weber, A. (1990), "EMU, asymmetries and adjustment problems in the EMS", CEPR Discussion Paper No.448.

White, H. (1980), "A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity", *Econometrica*, 48, 817-838.

Williamson, J. (1993), "The rise and fall of political support for EMU, in A.Giovannini et. al. (eds.), *The Monetary Future of Europe*, London: Centre for Economic Policy Research.

Wolf, H.C. (1994), "Growth convergence reconsidered", *Weltwirtschaftliches Archiv*, 130 (4),747-759.

Wyplosz, C. (1986), "Capital controls and balance of payments crises", *Journal of International Money and Finance*, 5,167-179.

Wyplosz, C. (1991), "Monetary union and fiscal policy discipline", in "The Economics of EMU", *European Economy*, Special Edition No.1.

Zellner, A. (1971), *An introduction to Bayesian inference in econometrics*, New York: Wiley.

SCHRIFTEN ZUR WIRTSCHAFTSTHEORIE UND WIRTSCHAFTSPOLITIK

Herausgegeben von Rolf Hasse, Wolf Schäfer,
Thomas Straubhaar, Klaus W. Zimmermann

Band 1 Lars Bünning: Die Konvergenzkriterien des Maastricht-Vertrages unter besonderer Berücksichtigung ihrer Konsistenz. 1997.

Band 2 Andreas Henning: Beveridge-Kurve, Lohnsetzung und Langzeitarbeitslosigkeit. Eine theoretische Untersuchung unter Berücksichtigung des Insider-Outsider-Ansatzes und der Entwertung des Humankapitals. 1997.

Band 3 Iris Henning: Die Reputation einer Zentralbank. Eine theoretische Untersuchung unter besonderer Berücksichtigung der Europäischen Zentralbank. 1997.

Band 4 Rüdiger Hermann: Ein gemeinsamer Markt für Elektrizität in Europa. Optionen einer Wettbewerbsordnung zwischen Anspruch und Wirklichkeit. 1997.

Band 5 Alexander Tiedtke: Japan und der Vorwurf des Trittbrettfahrerverhaltens in der US-amerikanisch-japanischen Allianz. 1997.

Band 6 Wolfgang Grimme: Ordnungspolitisches Konzept der Regionalpolitik. Darstellung der Defizite und des Reformbedarfs der Regionalpolitik am Beispiel Mecklenburg-Vorpommerns. 1997.

Band 7 Christian Ricken: Determinanten der Effektivität der Umweltpolitik. Der nationale Politikstil im Spannungsfeld von Ökonomie, Politik und Kultur. 1997.

Band 8 Christian Schmidt: Real Convergence in the European Union. An Empirical Analysis. 1997.