International Institute for
Applied Systems Analysis
Schlossplatz 1
A-2361 Laxenburg, Austria

Tel: +43 2236 807 342
Fax: +43 2236 71313
E-mail: publications@iiasa.ac.at
Web: www.iiasa.ac.at

Interim Report IR-01-035/September

Growth Effects of EU Membership: The Case of East Germany

Erich Gundlach (EGundlach@ifw.uni-kiel.de)

Approved by

János Gács (gacs@iiasa.ac.at)
Project Leader, Economic Transition and Integration

September 2001

Contents

Abstract

The East German experience with EU membership (after unification in 1990) probably comes close to what might be called a controlled experiment for assessing the growth effects of EU membership. East Germany could rely on the tried and tested rules and institutions of the West German social market economy and had immediate access to large amounts of financial resources in the form of public transfers. Notwithstanding these rather unique favorable starting conditions, high-flying expectations have been disappointed so far.

This paper uses an open-economy neoclassical growth model as a measure of reference against which the actual performance of the East German economy can be evaluated. Ignoring the very first years after unification, the theoretically predicted growth rate for the period 1993-2000 exceeds the observed growth rate by an order of magnitude. With no obvious differences in institutions and technology, and with physical capital accumulation in East Germany exceeding the West German rate, differences in human capital remain as the major reason for differences between the theoretical and the actual East German growth rate. Simulation results suggest that East Germany's stock of human capital per worker reaches only about one third of the West Germany level.

The possibility that human capital rather than physical capital seems to be the decisive bottleneck for growth and convergence should dampen overly optimistic growth expectations of EU membership in the present group of accession countries. Since the economically relevant stock of human capital cannot be increased as easily as the stock of physical capital, the main lesson from the East German experience for other EU accession countries is that catching up may come to a halt below the EU average, even under pretty favorable institutional and financial conditions.

Foreword

by János Gács

This paper is one of the results of a broad, multi-year research project of the Economic Transition and Integration Project of IIASA entitled "Catching Up and EU Accession – Prospects for First and Second Wave Countries". The research was particularly encouraged by IIASA's Swedish and Hungarian national member organizations, while financial support was provided by the (then) Swedish national member organization, the Swedish Council for Planning and Coordination of Research (FRN). Preparations for the project started in 1999. In addition to other forms of communication two workshops, one in Budapest in January 2000, and one in Stockholm in May 2001, helped to elaborate the research agenda, coordinate collaborative work and discuss results. Publication of the studies prepared in the framework of this projects started in September 2001.

The main ideas of the research project can be summarized as follows.

The accession of the Central and East European countries (CEECs) to the EU is likely to lead to conflicts between these countries and the incumbent members unless there is a rapid narrowing of the gap in per capita incomes between them. The CEECs are much poorer and have proportionately much larger agricultural sectors than the average EU country, and their combined populations make up between one-fourth and one-third of that of the current EU. Due to these characteristics there is concern in EU member states about a mass migration from the East following accession, about social and environmental "dumping" from CEECs, and about an increased demand by the CEECs on the EU's Structural and Cohesion Funds, as well as on the funds provided under the Common Agricultural Policy.

These concerns, however, are counterbalanced to a large degree by a "catching up" predicted by both theory and experience: poorer countries, unless their development is impeded by institutional barriers, usually develop faster than richer ones, and there is a tendency toward convergence in levels of GDP per capita. In recent years, this catching up process seems to have started. In addition, trends in capital inflows and stock market developments suggest that the expected return on capital in the region is sufficiently high to support the buildup of stronger production capacities.

The research project on catching up studied the pattern according to which preparations for membership can trigger changes that will affect the growth process before and after membership. Special attention was paid to CEECs in different positions: those that started negotiations in 1998 and may reach membership first, and those that started negotiations in 2000. The effects on the sources of growth in both the pre-accession and post-accession periods were studied.

The following specific topics were investigated by the contributors of the project: the relevance of the export led East Asian development experience for CEECs; the forces of convergence and divergence that worked in the less developed EU member states (Spain, Portugal, Ireland and Greece) following their accession; the mixed experience of East Germany in catching up in a growth theoretic perspective; the role of domestic savings and savings behavior in the catch-up process; the likely pattern of the so-called Balassa-Samuelson process (real appreciation associated with the expected rapid productivity growth) in the course of the convergence; evaluation of the possible effects of EU structural aid on the candidate countries' development based on the experience of the cohesion countries of the EU; financial convergence of the candidate countries to the EU and the growth process; the role of institutions in the process of transition and catching up; and the relationship between the growth process and human development (health, education, standard of living, including inequality) in the context of EU accession.

Acknowledgments

The author thanks participants of a workshop in Stockholm and especially János Gács and Vladimír Benáček for constructive comments on an earlier version, and Mombert Hoppe for able research assistance.

About the Author

Erich Gundlach is Head of Research Group "Human Capital and Economic Growth" at the Department "Development Economics and Global Integration" of the Kiel Institute of World Economics in Kiel, Germany. In 2000-2001 he participated in the reserach project „Catching Up and EU Accession – Prospects for First and Second Wave Countries" of the ETI project of IIASA.

Growth Effects of EU Membership: The Case of East Germany

Erich Gundlach

I. Introduction and Overview

Economic history provides some examples for economic miracles with exorbitant rates of growth after natural disasters or man-made catastrophes. What happened in the aftermath of the devastating Kobe earthquake in January 1995 is probably the most recent example for an economic miracle following a natural disaster. Although almost all infrastructure including roads, utilities, and the port facilities had been destroyed, manufacturing output in the greater Kobe area and the volume of international trade passing through its port were back at their pre-quake levels only one year later (Horwich 2000). Somewhat closer to the topic of this paper, the West-German experience after the currency reform of 1948 has been regarded by many as an example for an economic miracle in the aftermath of a terrible man-made catastrophe. As early as 1950, West German industrial production had roughly doubled and growth remained strong for about the next 25 years (Giersch et al. 1992).

These examples show that high rates of growth and convergence to a persistently high level of the standard of living are possible if the destruction of specific economic assets can be substituted for by other economic assets. Given the historical record, it is therefore understandable that German unification (and hence East Germany's EU membership) in 1990 immediately raised high-flying expectations of "blossoming landscapes" in the eastern Länder within less than a decade. A similar reasoning seems to prevail in many new EU accession countries.

Such an optimistic view was (and is) obviously founded on the idea that a lack of physical capital, which can fairly easily be overturned, is at the heart of the fairly large differences in the standard of living between new and old EU members. However, as the East German experience since unification shows, physical capital accumulation does not appear to be the decisive bottleneck for faster economic convergence to the West German level. The same may hold for many new EU accession countries.

More generally, the prospects for EU enlargement probably in more waves in the near future have refocused research interests on the likely growth effects of membership in the accession countries. This empirical interest coincides with the renewed interest in the theory of economic growth. Unfortunately, many new growth models do not identify a clear-cut set of factors which determine growth, or are more or less resistant to empirical applications. Hence new member countries are confronted with a wide array of theoretically consistent, but empirically unknown and sometimes even conflicting implications for economic policies aiming at realizing all potential growth effects of EU membership.

In terms of neoclassical growth theory, which has remained the workhorse for empirical growth research, EU accession means that new members can settle on a steeper convergence path that would not be achievable otherwise. According to this theory, the higher rate of convergence would result from an improved standing as a borrower on international capital markets due to EU accession. Faster convergence would mean a higher present value of future incomes and hence a higher average growth rate until the steady state is reached. But this theory does not necessarily suggest that all countries should converge to the same steady state, as long as there are differences in technology and preferences across countries. For instance, some countries may de facto restrict foreign direct investment due to linguistic or cultural barriers in one way or another and hence may not have access to the latest technologies. Other countries may have low savings and investment rates because of a weak institutional enforcement of property rights as experienced under a long period of socialist planning. In the long run, such differences should clearly diminish under a common set of EU institutions, but in the short to medium run substantial differences are likely to remain across countries with different economic and political histories.

An important implication of neoclassical growth theory is that subsidized capital flows distributed to new members through various EU funds should not be misunderstood as the main benefits of EU integration. Subsidized capital flows tend to compensate for perceived differences in technology and capital accumulation between new and old EU members without changing the underlying set of incentives and preferences which gives rise to these differences in the first place. As long as differences in technology and preferences remain, steady states will also continue to differ. Large scale transfers, as in the case of East Germany, could actually reinforce existing structural differences and create incentives that could lead to the emergence of a second Mezzogiorno (Sinn and Westermann 2001). In a similar way, new member countries may converge to a steady state which lies below the present EU average, depending on the magnitude of the remaining cultural and political differences which may show up as institutional ambiguities, at least in the short run.

The East German experience with EU membership (after unification in 1990) probably comes close to what might be called a controlled experiment for assessing the growth effects of EU membership. This is because East Germany received not only a complete set of institutions appropriate to advanced industrial countries, but also access to experienced administrators to run those institutions. Apart from having gained free trade access throughout Europe, a legal system with a body of commercial law, a system of property rights, and a set of courts, a social system including unemployment compensation and a pension system with immediate entitlements for qualified recipients, a hard currency, a system of public finance, a banking system with branches that opened virtually immediately after unification, decentralized government authority, accounting systems, and strong democratic political parties were among the institutions imported (Dornbusch and Wolf, 1992).

What helped the introduction of these institutions were two special factors which will not apply in the case of new member countries. One is that unification created a legal union and so dispensed with the sovereignty issue that usually inhibits the complete import of institutions. Hence in the case of German unification, it would appear difficult to blame institutional ambiguities for presumed technological deficits or low saving and investment rates. The other is that a common institutional history

implied that institutions new to East Germany could nevertheless built on existing structures in many cases. Hence what might be called cultural differences also appears to be second order.

Notwithstanding these rather unique favorable starting conditions, high-flying expectations have been disappointed so far. Labor productivity in East Germany has reached about 60 percent of the West German level after ten years of EU membership. This is up from much lower levels in the early 1990s, but convergence of labor productivity and wages between East and West Germany has slowed down since the mid 1990s and completely faded out recently.

The rather dismal growth and convergence effects of East German EU membership are all the more remarkable just because East Germany could rely on the tried and tested rules and institutions of the West German social market economy. So the lack of fast convergence cannot be blamed on institutional insecurities, as might be the case for other potential member countries. In addition, East Germany had immediate access to large amounts of financial resources in the form of public transfers. Net resource inflows in the range of more than 40 percent of East German GDP in combination with an effective institutional framework should have generated very positive conditions for growth and convergence. Similar starting conditions will not be available for other accession countries.

A verdict on the growth performance of the East German economy in the first decade of EU membership requires a measure of reference. The problem with any empirical evaluation is that there are only ten years of observations, but several potential factors which contribute to enhancing and limiting economic performance. Hence econometric estimation is not feasible to account for the East German economic record. The alternative is to use a simple neoclassical growth model, which can be parameterized to predict a growth rate depending on initial conditions and on observed rates of factor accumulation. By comparing the predicted growth rate with the actual growth rate, such a simulation approach should reveal which factors of production may be responsible for the so far missing East German convergence to West German productivity levels.

To provide some conceptual background, Section II briefly summarizes recent developments in the theory of economic growth with a focus on the issue of convergence. Section III reviews stylized facts of the growth performance of the East German economy after unification and EU membership. Section IV presents an open-economy growth model that allows for partial capital mobility (Section IV), because large capital inflows are generally held to be one of the major determinants of the expected growth effects of EU membership.

Based on this model, Section V constructs a measure of reference against which the actual performance of the East German economy can be evaluated. The model predicts the level and the growth effects of convergence for the East German economy, based on its initially low level of productivity and based on its observed (or implied) rates of investment in physical and human capital, thereby assuming stable institutions (including a stable currency) and open goods and capital markets. Ignoring the very first years after unification, the theoretically predicted growth rate for the period 1993-2000 exceeds the observed growth rate by an order of magnitude.

Given that institutional and technological differences are not responsible for the failure of the model to account correctly for the relative East German growth rate, and since physical capital accumulation in East Germany presently exceeds the West German rate, reconciling the theoretical growth rate with the actual growth rate implies that the East German stock of human capital per worker is the main culprit. Human capital per worker is apparently much smaller than would be suggested by measures such as average years of formal education of the workforce. With a lower stock of human capital per worker than commonly presumed, the East German economy should converge to a lower steady state level of output per worker than the West German economy. This conclusion simply follows from the parameterization of the model, which assumes identical institutions and identical production technologies. Any evaluation of the plausibility of the identified deficiency in human capital has, therefore, to be compared against implementing alternative assumptions regarding institutions and technology.

In so far as the term institutions would also include the actual pattern of behavior of economic agents when confronted with a given constraint, there might still be important differences between East and West Germany that could simply reflect the legacy of 40 years of socialism that may persist for some time. But even so, it might be more helpful to call such differences, especially in the case of East Germany, a human capital gap rather than an institutional or a technological gap. The problem for any empirical assessment of the East German productivity record is that we may have fairly accurate measures of output and (probably) physical capital, but we certainly do not have any convincing measures of institutional differences, technological differences, and human capital differences. Previous studies have mainly ignored the possibility that measures of formal education may provide strongly misleading indicators of East Germany's stock of human capital. So these studies tend to overestimate the long-run possibilities for productivity growth and convergence.

This is even true for the assessment by Barro and Sala-i-Martin (1991), which was held to be extremely pessimistic at the time. Using their empirical estimate of a constant rate of convergence of 2 percent, which was based on a neoclassical growth model in the tradition of Solow (1956), they predicted that East Germany, when starting at about 50 percent of the West German productivity level after unification, would initially grow by only about 1.4 percentage points (the product of the convergence rate and the log of the initial productivity level) faster than the West German economy, with the growth differential narrowing as East Germany would be catching up. This would imply a rather slow catching up process with a half-life of about 35 years meaning that it would take 35 years until the East German economy would half reached 75 percent of the West German productivity level. Nevertheless, their prediction implies that in the long run, finally, the same steady state would be reached.

Dornbusch and Wolf (1992) provide variations of the same theme by noting that the initial income gap may have been closer to 70 percent than to 50 percent, which results in an initial growth differential of 2.4 percentage points. In addition, they note that allowing for a relatively high rate of physical investment may further increase the speed of convergence between East and West Germany. Yet the logic of the underlying growth model still suggests that catching up will be slow. Starting from an initial gap of 70 percent and by assuming the most favorable examples of investment-led catching up

processes known from the historical record, East Germany would still need almost three decades to achieve 80 percent of West Germany's productivity level.

Using simple arithmetic rather than a growth model, Hughes Hallet and Ma (1993), for instance, also demonstrate that given past experience a rather long period of East German catching up could be expected. The rapid development of West Germany under the Marshall plan, or of some East Asian countries in the 1980s and 1990s, produced sustained productivity growth rates averaging 6 to 7 percent at most. With East Germany starting at about 30 percent of the West German productivity level, full convergence within, say, 20 years would require the East German productivity growth 6 percentage points *higher* than in West Germany. By this measure, a period of 30 to 40 years to achieve convergence looks like a very optimistic assessment.

Boltho et al. (1997) confirm a more optimistic assessment based on their empirical results for the East German manufacturing sector. They report that physical capital investment has spurred productivity growth and hence catching up. They find that East German productivity is higher relative to that in West Germany in those manufacturing industries in which cumulative investment per employee has been the highest. They argue that prospects for a full catching up of East Germany are promising given that investment continues to be encouraged.

Funke and Strulik (2000) also point to a more optimistic outcome. They set up a two-region endogenous growth model that emphasizes the role of private and public capital accumulation during the catch up process. To assess the speed of convergence, they calibrate their model with German data, thereby including the large-scale interregional transfers. Their simulation results suggest that East Germany could reach 80 percent of West Germany's productivity level between 20 and 30 years after unification.

Focusing on the early period after unification, Keller (2000) estimates that relatively high technical progress in East Germany can explain almost all of the catch up with West Germany in 1991-1996. He emphasizes that the level of domestic innovative activity as well as the extent of international technology diffusion appear to be the main reasons for this. He concludes that ignoring potential East-West differences in the conventionally measured rate of total factor productivity may lead to underestimating the prospects for convergence and hence to an overly pessimistic assessment of East Germany's future similar to that of Italy' Mezzogiorno. His analysis suggests that East Germany could reach about 75 percent of the West German productivity level in a period of 20 years.

The problem is that much of the observed productivity dynamics of the East German economy has faded since 1996. Therefore, it is not surprising that the notion of a German Mezzogiorno has become more popular recently (Sinn and Westermann 2001). Another problem is that all studies referred to completely ignore that human capital deficiencies may play an important role. Barrel and te Velde (2000) at least mention in their conclusions that the problem of further convergence may be embedded in the stock of East Germany's human capital. They show that equations including both exogenous and endogenous technical progress are able to explain some of the initial convergence of productivity levels. However, they also note that the convergence process slowed in the late 1990s as privatizations were completed, which before helped to establish the transfer of technology and organizational structure from West German

and foreign firms. Hence they conclude that investment in human capital remains the only way to improve the stock of knowledge in the East German economy.

While it is certainly much too early to draw final conclusions about the future prospects for catching up and convergence of the East German economy, the possibility that human capital rather than physical capital seems to be the decisive bottleneck should dampen overly optimistic growth expectations of EU membership in the present group of accession countries. Especially Central European countries, like East Germany before, display measures of average years of schooling which sometimes even exceed the EU average. However, the simulations presented in this paper suggest that East Germany's stock of human capital per worker may turn out to be only one third of West Germany's stock of human capital per worker. These simulation results should be a warning not to take too seriously existing measures of formal education as appropriate proxies for the economically relevant stock of human capital.

Taking the simulation results at face value, the question immediately arises how the presumed human capital deficiency could be eliminated. Section VI concludes that raising the stock of human capital is more difficult than raising the stock of physical capital. Improving the quality of schooling should be an appropriate long-run strategy to raise the steady state level of output per worker, but recent empirical research suggests that merely raising public educational expenditures will probably not produce the expected outcome. In the short run, active labor market policies like the retraining of unemployed workers have been tried on a large scale, but with apparently little success so far. Hence the main lesson from the East German experience for other EU accession countries is that catching up may come to a halt below the EU average because the economically relevant stock of human capital cannot be increased as easily as the stock of physical capital, even under pretty favorable institutional and financial conditions.

II. Growth and Convergence: A Non-Technical Primer

About 15 years ago, the issue of economic growth returned to the center of macroeconomic research. New aggregate data sets for a larger number of countries became available (Summers and Heston 1984), and new theoretical insights led to what is now called new growth theory. New growth theories focus on the modeling of external effects in the presence of perfect competition and on the causes of technological change, which both were neglected before. The empirics of growth did not keep up with the theoretical advances. At present, growth theory is still ahead of empirics, where the traditional neoclassical growth model serves as the workhorse of almost all applied analyses.

In a sense, empirical research on growth may be summarized as the search for the weak spots in neoclassical growth models in the tradition of Solow (1956). Using the two factor inputs "capital" and "labor", the Solow model could neither convincingly explain the large international differences in per capita income nor the large international differences in growth rates. As a result of the seeming empirical failure of the Solow model, Lucas (1988) and Romer (1989) argued that there was a need for alternative growth models which could explain where growth comes from and why it may persistently differ across countries. The new growth models claimed to offer answers to both questions.

The main reason for the initial attractiveness of the new growth models resulted from a convincing explanation for the missing systematic catching up of poor economies, not to speak of international convergence of output per worker. For given parameterizations of preferences and technology, catching up and convergence should result if the rate of return tends to decline with higher levels of factor accumulation. A declining rate of return would reduce the growth rate predicted by the Solow model until the economy reaches its steady state, where the growth rate should equal the (exogenous) rate of technical progress. By implication, an economy far away from its steady state should grow faster than an economy close to its steady state.

According to this logic, poor countries should grow faster than rich countries because they have accumulated less capital and are, therefore, further away from their steady state. Selected developing countries, notably in East and Southeast Asia, have in fact grown much faster on average than many industrialized countries over the last decades, notwithstanding the financial crisis of the late 1990s. But for the world economy as a whole, a systematic catching up of poor economies is missing.

This is exactly what some of the new growth models predict. They assume that rising levels of factor accumulation would not reduce the rate of return and, therefore, would not reduce the rate of growth. According to this view, poor economies would only be able to catch up if they persistently achieved a higher rate of investment than the rich economies. But in contrast to the traditional model, there is no incentive to do so as long as the rate of return remains high in rich countries. Hence convergence may occur under certain conditions, but is not predicted as a regularity. So it seems tempting to explain the so far missing convergence of East Germany on the basis of a new growth model.

Yet the new models' claim to provide a better account of the facts did not remain unchallenged for long. First, the robustness of the model implications was doubted for theoretical reasons. For instance, Solow (1994), Sheshinsky (1997), and Jones (1997) noted that the growth implications of the new models tend to depend on a single parameter, which has to take on a specific value to prevent the model from exploding or from falling back to the traditional Solow case. Since there is nothing within the models which would guarantee a specific value of the critical parameter, one could view the new approaches as merely substituting one exogenous factor for another. Moreover, all new growth models relying in one way or another on the diffusion of knowledge as the engine of growth would face the same difficulty in explaining long-run differences in cross-country growth as the Solow model.

Second, the new models were also shown to be less convincing empirically than initially presumed. For instance, so-called R&D growth models suggest that the growth rate of an economy should rise with its expenditures on basic research and development. Such expenditures have in fact risen in OECD countries over the last 30 years or so, but their growth rates tend to have declined as observed by Jones (1995). In addition, different econometric time series techniques were shown to produce inconclusive results with regard to convergence, so the available data obviously do not answer the question which kind of growth model has to be preferred (Gundlach 1993).

Along with the proliferation of new growth models over the last decade, the empirically motivated critique of the Solow model also generated a research program looking for possible theoretical improvements of the Solow approach while at the same

time preserving its empirical accessibility. This research program proved to be successful in so far as international differences in growth rates could be explained as reflecting transitional dynamics, i.e. as a fairly slow adjustment of each economy to its own steady state. This come back of the Solow model in a different form has been labeled "neoclassical revival" (Topel 1998).

The neoclassical revival does not mean that the last word is spoken in the theory and the empirics of growth. For instance, a better theory of total factor productivity growth or of technical progress is certainly needed for convincing explanations of the mere existence of growth and probably also for more insightful explanations of persistent differences in growth rates, as argued by Hall and Jones (1999), Klenow and Rodriguez-Clare (1997), and Prescott (1998). But for the topic of this paper, a model which tries to explain observed differences in growth rates as reflecting different distances from a common steady state seems to provide a most reasonable starting point. After all, EU integration is meant to adopt a common set of laws, social norms, and institutions. Without any apparent reason why technology should not flow freely within the EU (or within Germany, for that matter) and given that factor mobility prevails, a convergence of income levels should result at least in the long run.

The model to be used in the next section avoids some of the often-noted weak spots of neoclassical growth theory in the tradition of the Solow model. First of all, human capital is considered as a third factor of production. In their seminal paper, Mankiw et al. (1992) showed that a human capital augmented Solow model does a good job in explaining international differences in the level of output per worker and in the average growth rate of output per worker. One implication of the augmented growth model is that it predicts a much lower rate of convergence to the steady state than the original Solow model if human capital accounts for a share of factor income which is at least as large as the share of physical capital. With a broad capital share of about 80 percent, the augmented model would predict a rate of convergence to the steady state of about 2 percent, as shown in Barro and Sala-i-Martin (1992). Since many empirical studies have in fact confirmed an empirical rate of convergence of about 2 percent, this stylized fact is sometimes called "Barro's Law".[1]

Introducing human capital as a third factor of production into the Solow model reconciled theoretical predictions of the rate of convergence with empirical evidence, but it immediately generated a new theoretical problem. The augmented Solow model only provides a plausible theoretical rationale for a slow rate of convergence if capital is perfectly immobile across economies. With high capital mobility, as is observed within the European Union and especially within the United States, the rate of convergence should be much higher than just two percent. In a fully integrated capital market, the speed of convergence should actually be infinitely high according to the logic of the augmented Solow model. With no restrictions on capital flows, each economy (each US state, for that matter) should immediately jump to its steady state output level. But this obviously does not happen: the rate of convergence across US states was also found to be about 2 percent (Barro and Sala-i-Martin 1992).

To solve this problem, Barro et al. (1995) suggested to allow for partial mobility of capital only. Their model assumes that physical capital can be financed by external

[1] See Sala-i-Martin (1996) for a survey of the empirical literature on convergence.

borrowing because it can serve as collateral, but human capital must be financed by domestic savings. If the amount of external debt that can be accumulated is constrained by the size of the domestic capital stock, the augmented Solow model again predicts a rate of convergence both with and without capital mobility in the range of 2 percent. Hence the augmented Solow model with partial capital mobility can account for the international and interregional evidence on convergence.

Just because the rate of convergence appears to be rather low, the model can be used for economic policy considerations focusing on growth. If the rate of convergence were high, the model economy would be predicted to be always close to its steady state where changes in factor accumulation - investment in physical and in human capital - would only affect the level of output per worker, but not the growth rate. But if the rate of convergence is actually low, higher investment in physical and human capital will raise the growth rate for a relatively long time period. Not least because of these features, the augmented Solow model with partial capital mobility seems to provide an appropriate measure of reference for evaluating East Germany's record on growth and convergence.[2]

III. Output and Factor Input in East Germany after Unification: Some Stylized Facts

One year after unification, East Germany's GDP per working-age person was estimated to be about one third of the West German level. It roughly doubled over the following five years but has remained at a level of about 60 percent of the West German level ever since (Figure 1). These simple facts can be interpreted from two perspectives. East Germany's productivity record certainly is a success story compared to many other transition economies, where the initial fall in output has been much larger and the subsequent recovery has been much smaller (Fischer and Sahay 2000). But by comparing East and West Germany's level of labor productivity, it turns out that not everything is well. Given that there are no limitations in factor mobility and capital flows, it would be reasonable to predict a gradual and probably fast process of convergence of labor productivity. But this does not seem to happen, at least not as fast as was initially expected. The question is why.

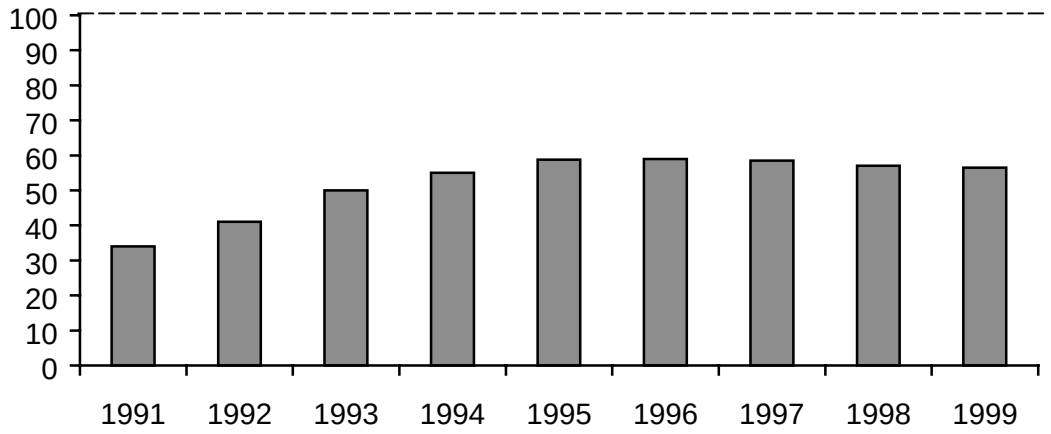
In terms of basic growth models, the perceived lack of convergence may reflect inherent differences in capital accumulation which persist at least in the medium run despite unlimited capital mobility. However, differences in physical capital accumulation do not appear to be a major part of the story. Figure 2 shows that overall investment per working-age person has been up to 50 percent higher in East Germany than in West Germany since 1993. Equipment investment has fallen below the West German level recently but also remains quite high. If anything, total investment in physical capital per working-age person is higher in East Germany than in West Germany. Together with the evidence for the level of labor productivity reported in Figure 1, this implies that investment as a share of GDP *(I/Y)* is about twice as high in East Germany than in West Germany, just because

[2] See Barbone and Zalduendo (1997) for an econometric estimation of the closed economy Solow model and an assessment of the potential EU Accession of Central and Eastern Europe.

(1) $$I / Y = (I / L) / (Y / L) \quad ,$$

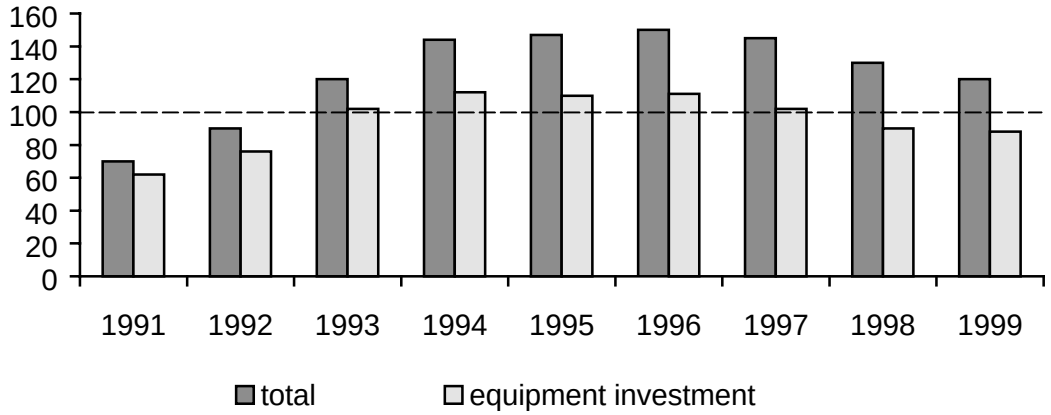
where *I/L* is investment per working-age person (which is set to 120 percent) and *Y/L* is GDP per working-age person (which is set to 60 percent). Taken at face value, this should have generated very favorable conditions for convergence.

Figure 1 — GDP per Working-age Person in East Germany, 1991–1999[a]



[a]West Germany (including West Berlin) = 100.
Source: Sinn (2000).

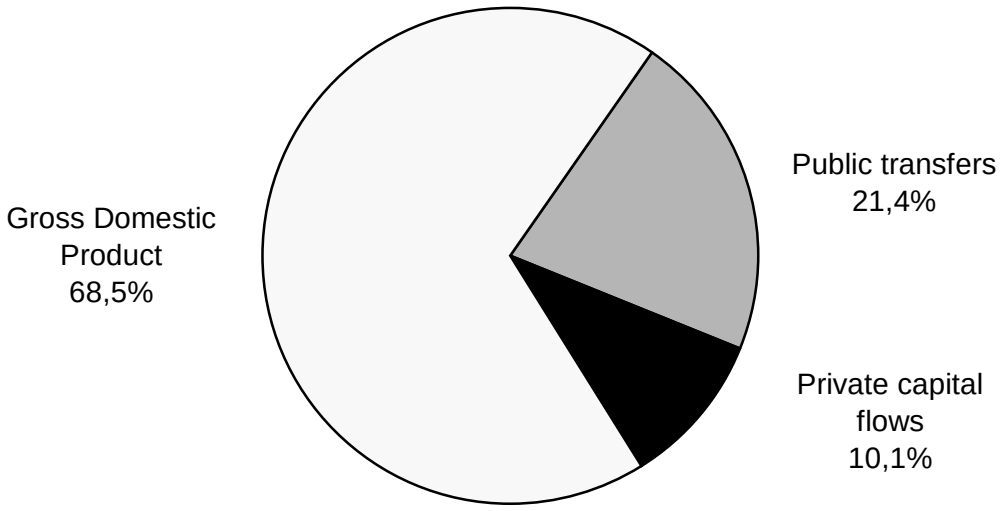
Figure 2 — Investment per Working-age Person in East Germany, 1991–1999[a]



[a]West Germany (including West Berlin) = 100.
Source: Sinn (2000).

One reason for concern is that the resources invested are only partly generated by the East German economy itself, as can be seen from the structure of absorption. There has been a large net resource inflow which amounted to more than 30 percent of total absorption in 1999 (Figure 3). Hence every third Deutsche Mark spent in East Germany came from the West. This means that the net resource inflow from abroad, which could be considered to equal to East Germany's fictitious trade deficit (goods and services) with West Germany, accounted for 46 percent of the East German GDP in 1999.

Figure 3 — The Structure of Absorption of the East German Economy, 1999



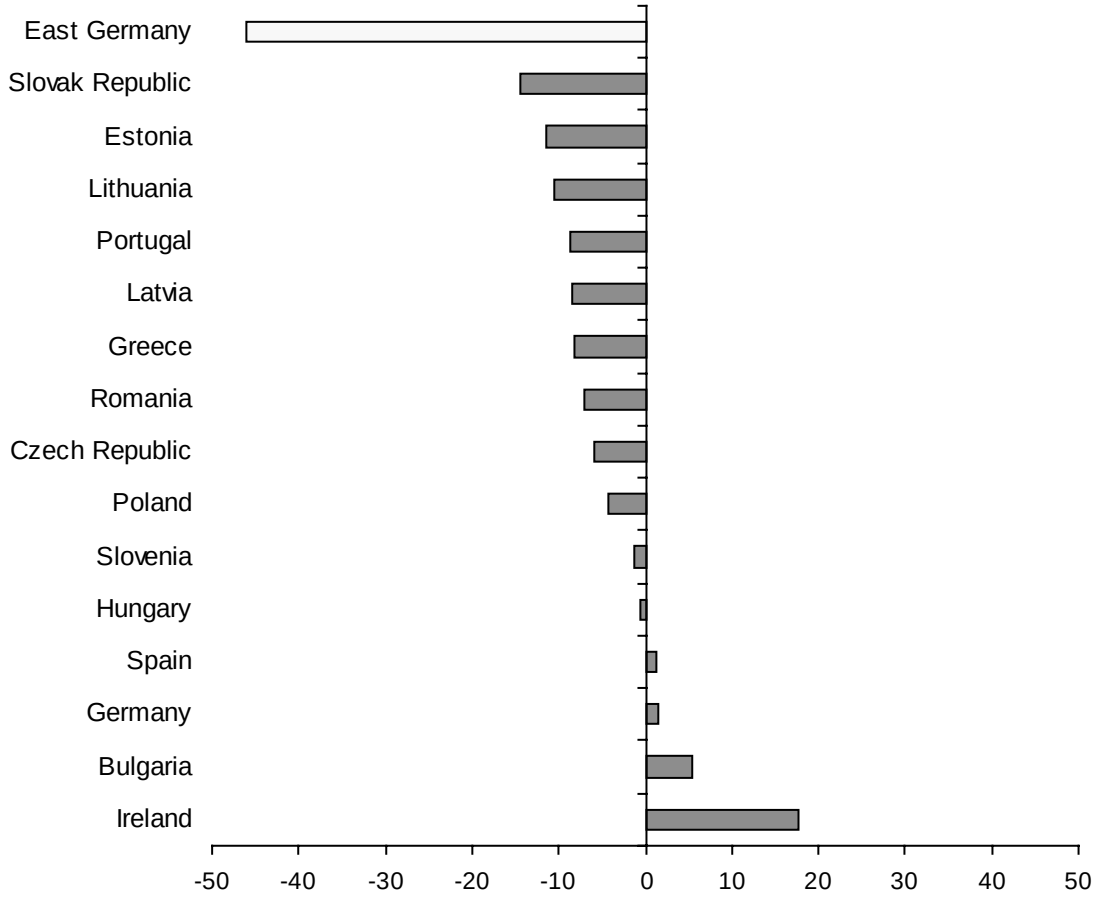
Source: Sinn (2000).

About two thirds of the net resource inflow is financed by public transfers, and one third by private capital flows. More than half of the transfers is for social security payments and only 12 percent is for investment in public infrastructure (Sinn 2000). Private capital inflows not only include direct investment in plant and equipment, but also business loans and public loans. Hence the relatively high figure for private capital flows, which amounts to 15 percent of the East German GDP, does not necessarily reflect excellent investment opportunities but is at least partly due to borrowing by the East German Länder and municipalities (Gemeinden).

To put East Germany's net resource inflow into perspective, Figure 4 lists other transition economies and selected EU member countries in descending order of their trade balance. The size of East Germany's trade deficit in the range of 45 percent of its GDP appears to be rather unique, not only compared to the countries listed in Figure 4. Except for Armenia, there seems to be no other economy around the world which manages to run a trade deficit that large. And if economic history is any guide, trade deficits larger than 10 percent of GDP are most likely to be unsustainable. This may be different in this special case, but there are some doubts whether the current size of the

West-East resource transfer could go on forever. If not, East German consumption would have to decline in order to maintain a high rate of capital accumulation.

Figure 4 — East Germany's "Trade Deficit" in Perspective[a]



[a]For East Germany: public transfers and private capital flows from West Germany in percent of East Germany's GDP, 1999; for all other countries: difference between exports and imports of goods and services in percent of GDP (negative values indicate net resource inflows), 1997.

Source: Figure 3 and World Bank (2000).

At present, East Germany's trade deficit looks more like an import share of a small open economy. The by and large missing East German export sector is actually one of the major differences between East and West Germany. One reason for the missing export share is that the East German manufacturing sector drastically declined in the first two years after unification, when labor costs exploded due to a centralized system of wage bargaining between labor unions and employer organizations that was imported from the West. This system of wage bargaining aimed a fast convergence between East and West German wage levels without considering differences in

productivity and without taking into account the resulting unemployment in East Germany, which is more than twice as high on average than in the West.

One consequence of the introduction of the administered fast convergence of East German wages has been that the East German capital stock could not be adjusted gradually to shift from labor-intensive to capital-intensive production while at the same time maintaining a high level of employment. The wage explosion caused a large economic destruction of the existing stock of physical capital and a large decline in employment, especially in manufacturing. Since a large wage gap between East and West Germany was held to be unacceptable for political and social reasons, despite a large gap in productivity, capital formation was highly subsidized especially until the end of 1996 in order to generate the investment necessary for the process of transformation and convergence.

Until about 1994, high investment rates did not translate into a fast growing stock of capital per worker because of the high depreciation rates which reflected the economic decline of the existing stock of capital. Disaggregated data for selected industries show that East Germany had a relatively low stock of physical capital per person relative to West Germany in 1994, especially in manufacturing and in services (Figure 5). The total capital intensity was estimated to be about 38 percent of the West German level. Together with the data on labor productivity from Figure 1, these figures suggest that the capital-output ratio in East Germany was also lower than in West Germany in 1994,[3] just because

$$(2) \qquad K / Y = (K / L) / (Y / L) \ ,$$

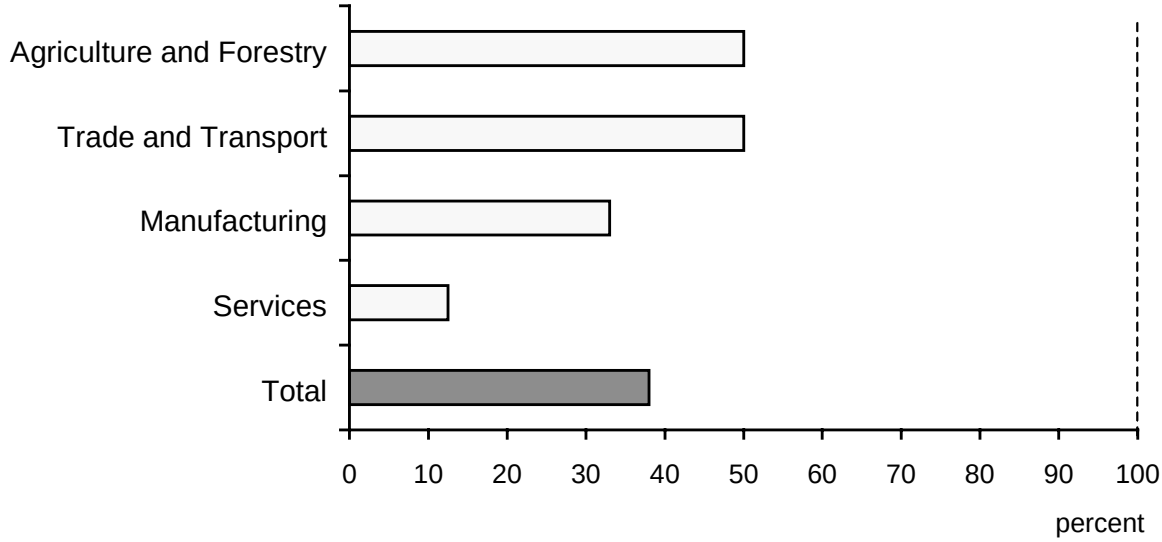
where *K/Y* is the capital output ratio, *K/L* is capital stock per person (capital intensity), and *Y/L* is GDP per working-age person.

But this has changed once the highly subsidized investment activities in East Germany actually generated a net increase in the stock of capital after 1994, and especially so in manufacturing which had experienced the largest economic decline of all sectors. The manufacturing sector which has emerged under these conditions operates at a relatively high capital-output ratio. Figure 6 actually shows that with only one exception,[4] all East German manufacturing industries display a higher capital-output ratio than their West German counterparts. A linear regression of the East German capital-output ratio on the West-German capital-output ratio, which is forced to run through the origin, produces a statistically significant slope coefficient of 3.1 and an adjusted R squared of 67 percent. Hence the capital-output ratio in manufacturing in East Germany was about two hundred percent higher than in West Germany in 1997.

[3] The data from Figures 1 and 5 cannot be directly compared because they refer to different denominators, namely working-age persons (Fig.1) and all persons living in the respective area (Fig.5) but are nevertheless instructive for a qualitative assessment.

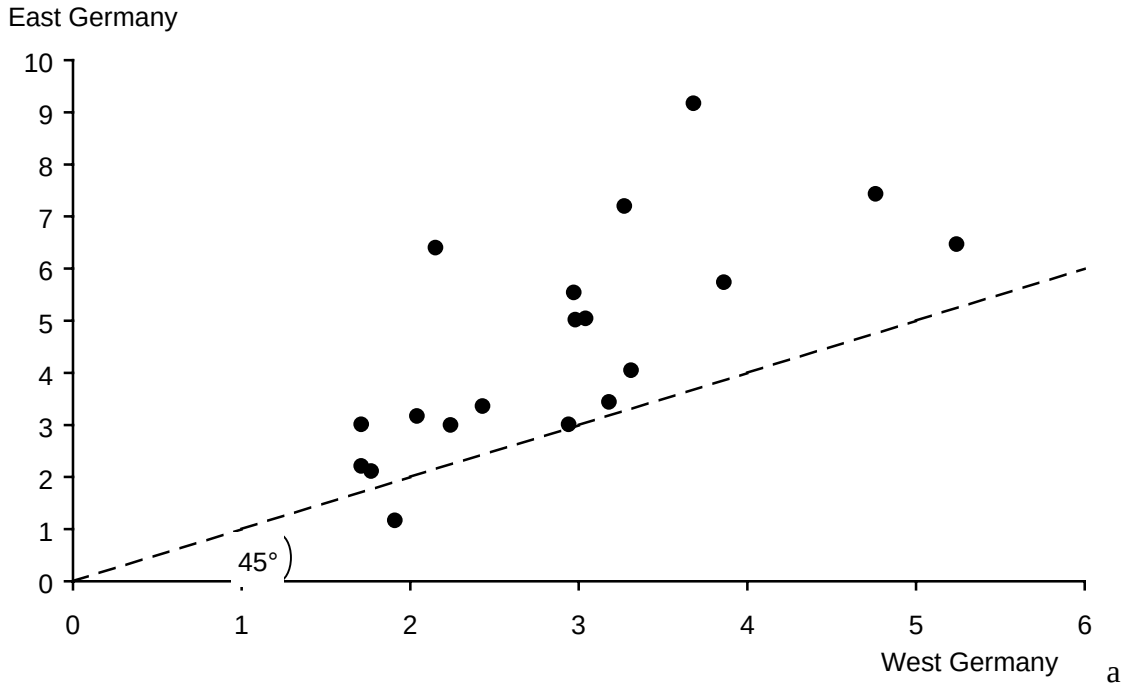
[4] The exception is precision engineering. In this industry, East Germany hosted some of the most productive European firms before the second world war.

Figure 5 — Capital Stock per Person in East Germany, 1994[a]



[a]West Germany = 100.
Source: DIW (1995).

Figure 6 — Capital-Output Ratio Across Manufacturing Industries[a], 1997



[a] Capital intensity divided by labor productivity; 19 two-digit industries. Data on capital intensity and labor productivity taken from DIW et al. (1999).

Source: DIW et al. (1999), own calculations.

For the total East German economy, the capital stock per person employed was estimated to be about 76 percent of the West German level in 1998 (Ragnitz 1999). This number is not directly comparable with the data on labor productivity in Figure 1, which refer in the denominator to working-age persons rather than persons employed. Nevertheless, this estimate seems to suggest that the aggregate capital-output ratio is higher in East Germany than in West Germany. This follows because output per person employed in East Germany, like output per working-age person, reached about 60 percent of the West German level in 1997. The reason for the similarity of these figures is that higher East German unemployment is compensated for by higher East German labor force participation. So the best guess is that the aggregate East German capital-output ratio was about 30 percent higher than in West Germany in 1998.

Notwithstanding possible reservations about the precise magnitudes of the capital stock estimates, which probably do not adequately reflect the specific conditions prevailing in the early phases of transition, the overall impression one gets is that lacking physical capital accumulation cannot be considered as the major problem for the missing convergence of the East German economy. The simple fact remains that even in manufacturing, where substantially more physical capital is now used per unit of output than in the West, labor productivity on average did not exceed two thirds of the West German level in 1998 (DIW et al. 1999). That is, if physical capital deficiencies do not turn out to be the decisive bottleneck for fast convergence, human capital deficiencies may provide a much better explanation.

For other transition economies, it may also be reasonable to hypothesize that human capital deficiencies are an important part of the story. But if this is actually the case it will be much harder to prove than in the case of East Germany. What makes the East German case very special is that institutional differences or technological differences cannot easily be blamed for the missing convergence, as argued in Section I. With unification, East Germany could adopt the tried-and-tested institutional framework of the West German economy. This framework may not be optimal. For instance, a less complicated legal system or somewhat less stringent conditions for construction permits might have been more suitable for rapid transition (Dornbusch and Wolf 1992), and the imposed system of centralized wage bargaining has proved to be a liability. But on balance, it seems that the possibility to import and immediately implement West German institutions was an asset. Had East Germany tried to create its own set of institutions, as other transition economies have to at least to some extent, results would most likely be worse. Since it did not, having the same set of institutions should lead to the same long-run steady state in the East and the West, given that there are no persistent differences in preferences regarding saving and investment. Similarly, with full capital mobility after unification, there is no reason to believe that the East would be somehow cut off from the technologies used in the West.

While institutional differences may persist for some time after accession in case of new EU members for, say, historical, legal, cultural, or linguistic reasons, such differences cannot matter much in case of East Germany. Unification not only brought the same currency and the same legal framework, it also meant immediate integration into the same social infrastructure including, for instance, the health system, the education system, the pension system, and the unemployment insurance system. Hence

from the macro-perspective of a growth model, differences in the quality of the workforce remain as the most plausible reason for the persisting differences in output per working-age person once differences in institutions, technology, and physical capital accumulation are obviously small or do not exist at all.

Unfortunately, very little direct information exists on the relative quality of the East German and the West German workforce. And the evidence that exists sometimes points to different conclusions. For instance, average years of education in the population aged 25 and over were higher in East Germany by about 10 percent than in West Germany in 1990, as reported by Barro and Lee (2000). Wagner (1993) points out that formal training levels across manufacturing industries are higher in East Germany than in West Germany. Given that there were actually no severe differences in the formal qualification of the workforce, and especially no deficiencies on the eastern side, informal qualification levels could be expected to converge quickly once East German workers are completely integrated into market-oriented production structures.

However, measures of formal schooling and training may only allow for a partial picture of the economically relevant stock of human capital as long as the economic return to education and the relative quality of education produced by different educational systems are not taken into account (Gundlach et al. forthcoming). The brain drain that occurred in the early years after unification also seems to indicate that probably some of the most motivated (young) and most productive (skilled) workers have left the East German labor force. Hence it may be no coincidence that the share of employees with tertiary education declined in East German manufacturing from 35.5 percent to 30 percent in 1991-1998 while it rose from 30.8 percent to 36 percent in West German manufacturing over the same time period (Klodt 2000).

Taken together, the following stylized facts about output and factor input of the East German economy after unification emerge. Labor productivity doubled from 30 percent of the West German level to about 60 percent within five years but has remained at about that level ever since. Physical capital accumulation appears to be strong: investment as a share of GDP and the capital-output ratio are higher than in West Germany and there is a large net resource inflow. Whether human capital input is also strong cannot be decided on the basis of the available data. In the next section, I present a neoclassical model of growth and convergence in order to simulate the implied level and growth effects of convergence on the basis of the available input data. Given that the observed productivity gap and the amount of physical capital accumulation is correctly measured relative to West Germany, such a model can also be used to reveal a hypothetical relative stock of human capital. Such an assessment may be especially relevant for other transition economies with a high level of formal education of the workforce.

IV. A Model of Growth and Convergence with Partial Capital Mobility

In the augmented Solow model with partial capital mobility of Barro et al. (1995), output is produced with four factors: physical capital, human capital, raw labor, and technology. Thus, assuming that the production function is Cobb-Douglas,

$$Y = K^{\alpha} H^{\eta} (AL)^{1-\alpha-\eta} \quad , \tag{3}$$

where Y is output, K is the stock of physical capital, H is the stock of human capital, L is the quantity of raw labor, A is the level of technology, and α and η are production elasticities which resemble the shares of physical and human capital in factor income (with $\alpha + \eta < 1$). Raw labor grows at the constant, exogenous rate n, and g is the constant, exogenous rate of labor augmenting technological change with $A(t) = A(0)e^{g \cdot t}$.

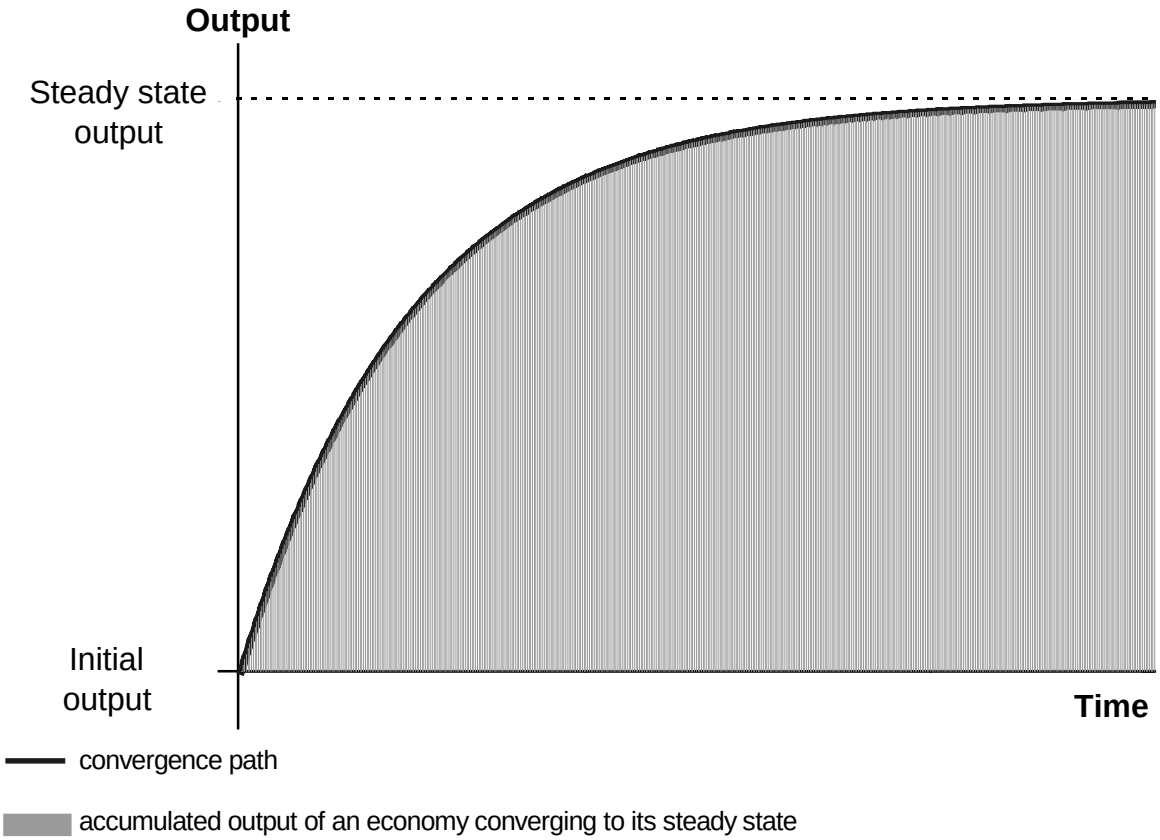
With perfect capital mobility and unlimited abilities to borrow on the international capital market, a small open economy (like Eastern Germany after unification) should jump instantaneously to its steady state levels of output, physical capital, and human capital according to the logic of the model. To avoid the implication of an infinite speed of convergence, Barro et al. (1995) assume that the amount of external debt which a country accumulates is constrained by the quantity of its capital stock that can be used as collateral for international borrowing. Hence in the model, physical capital is partially mobile across economies because it can be used as collateral, while human capital is completely immobile and has to be financed entirely by domestic savings. Human capital in fact seems to be more or less immobile across East and West Germany since there has been almost no net East-West migration in recent years (Hunt 2000).

Barro et al. (1995) show that the open economy with partial physical capital mobility works like a closed economy with a broad capital share that is less than $\alpha + \eta$. In the open economy case, the possibility of external borrowing (limited by the size of the domestic capital stock K) allows for a relatively fast accumulation of physical capital. Therefore, the open economy displays a higher rate of convergence than the closed economy. Even though the difference in convergence rates turns out to be small for a standard parameterization of technology and preferences, open economies are predicted to reach their steady state earlier than closed economies. Hence partial physical capital mobility allows for a higher present value of all accumulated future output flows compared to a situation without capital mobility.

At this point it is worth emphasizing that the convergence rate should not be confused with the actual growth rate of an economy. The convergence rate depends on a set of technology and preference parameters which tend to be similar across economies (see equation (21) in Section V). Therefore, the rate of convergence may be the same for different economies, as is assumed in the empirical convergence literature beginning with Mankiw et al. (1992). By contrast, the actual growth rate of an economy depends on the initial distance from the steady state and on the level of the variables determining the steady state. In the empirical growth literature, a clear distinction between the rate of convergence and the actual growth rate of an economy is sometimes missing.

Figure 7 shows the transition path of an economy starting below its steady state level of output. The transition path is entirely determined by the constant rate of convergence, which measures the speed at which an economy gradually approaches its steady state. A slightly higher rate of convergence, as would be the case with partial capital mobility compared to complete capital immobility, implies a steeper transition path. For a given steady state, a higher rate of convergence would mean a higher rate of growth, but for a given rate of convergence the growth rate would be entirely determined by the distance from the steady state.

Figure 7 - Convergence and Accumulated Output



The shaded area below the transition path represents the output which is accumulated in the transition to the steady state. Hence knowing the rate of convergence of an economy and its initial distance from the steady state, it becomes possible to calculate the present value of the accumulated output flows, as shown by Gundlach and Diehl (1999). The present value (*PV*) of output growth which results from convergence to the steady state is given by

$$(4) \qquad PV = \sum_{t=1}^{\infty} \left(\frac{1}{1+r} \right)^{t} \left(y(t) - y(0) \right) \ ,$$

where *r* is the steady-state real interest rate, *y(t)* is output at time *t*, and y(0) is initial output, with $y_t > y_0$. As is customary in the growth literature, output is measured in units of effective labor $\left(y \equiv Y / AL \right)$. Dividing both sides by $y(0)$ and using the log-approximation $\frac{y(t) - y(0)}{y(0)} \cong \log y(t) - \log y(0)$, it follows that

$$(5) \qquad \overline{PV} = \frac{PV}{y(0)} = \sum_{t=1}^{\infty} \left(\frac{1}{1+r} \right)^{t} \left(\log y(t) - \log y(0) \right) \ .$$

The second term of the right-hand-side can be substituted for an expression which describes the transition dynamics of the economy around the steady state. Mankiw et al. (1992) show that the transition dynamics around the steady state evolves according to

(6) $$\log y(t) = \left(1 - e^{-\beta t}\right)\log y* + e^{-\beta t}\log y(0) \ ,$$

where β is the rate of convergence and $y*$ is the steady-state income. Subtracting $\log y(0)$ from both sides gives

(7) $$\log y(t) - \log y(0) = \left(1 - e^{-\beta t}\right)\left(\log y* - \log y(0)\right) \ ,$$

which can be substituted into equation (5):

(8) $$\overline{PV} = \sum_{t=1}^{\infty}\left(\frac{1}{1+r}\right)^{t}\left(1 - e^{-\beta t}\right)\left(\log y* - \log y(0)\right) \ .$$

Equation (8) can be arranged by using the summation rule for a geometric progression given by $\sum_{t=1}^{\infty}\gamma^{t} = \frac{\gamma}{1-\gamma}$. The sums of the first two terms on the right-hand follow as

(9) $$\sum_{t=1}^{\infty}\left(\frac{1}{1+r}\right)^{t} = \frac{\frac{1}{1+r}}{1-\frac{1}{1+r}} = \frac{1}{r} \quad \text{and}$$

(10) $$\sum_{t=1}^{\infty}\left[\left(\frac{1}{1+r}\right)e^{-\beta}\right]^{t} = \frac{\left(\frac{1}{1+r}\right)e^{-\beta}}{1-\left(\frac{1}{1+r}\right)e^{-\beta}} = \frac{e^{-\beta}}{r+1-e^{-\beta}} \ ,$$

so the summation in equation (8) can be transformed to

(11) $$\overline{PV} = \left[\frac{1}{r} - \frac{e^{-\beta}}{r+1-e^{-\beta}}\right]\left(\log y* - \log y(0)\right)$$

$$= \left[\frac{(1+r)\left(1-e^{-\beta}\right)}{r\left(r+1-e^{-\beta}\right)}\right]\left(\log y* - \log y(0)\right) \ .$$

Using the Taylor expansion of $e^{-\beta}$ at $\beta = 0$, i.e. for the convergence rate to be a small number, it follows that $e^{-\beta} \cong 1 - \beta$, and hence $\beta \cong 1 - e^{-\beta}$. This result simplifies equation (11) to

(12) $$\overline{PV} = \left(\frac{1+r}{1}\right)\left(\frac{\beta}{r+\beta}\right)\left(\log y^* - \log y(0)\right) \ .$$

Reversing the first log-approximation used to derive equation (5), one ends up with

(13) $$\overline{PV} = \left(\frac{1+r}{r}\right)\left(\frac{\beta}{r+\beta}\right)\left(\frac{y^* - y(0)}{y(0)}\right) \ .$$

Equation (13) shows that the present value of the output accumulated during the convergence to the steady state depends on three variables: the real interest rate, the speed of the convergence towards to steady state, and the initial distance from the steady state. All other things constant, the present value rises with a lower real interest rate and increases with a higher convergence rate and a larger distance from the steady state. Since the real interest rate and the convergence rate can be calculated as functions of preference and technology parameters, equation (13) can be used to calculate the present value of the output effect of convergence as a multiple of the initial output for a given distance from the steady state (see Section V.1).

In addition to estimating the infinite level effect of convergence, the model also predicts the impact of convergence on the growth rate of output per worker for a given period of time and a given distance from the steady state. Rewriting equation (7) in terms of output per worker gives

(14) $$\log\left(Y(t) / L(t)\right) - \log\left(Y(0) / L(0)\right) = gt + \left(1 - e^{-\beta t}\right)\left(\log y^* - \log y(0)\right) \ ,$$

where *Y/L* is output per worker, *y* is output in efficiency units as before, *t* is time, and $A(t) = A(0)\, e^{gt}$, so $\left(\log A(t) - \log A(0)\right) = gt$. To see what differences alternative rates of factor accumulation may make, the steady state output *y** can be proxied by its determinants. As shown by Mankiw et al. (1992), deriving the steady state levels of physical and human capital and substituting into the intensive form of the production function (3), and taking logs, it follows that steady-state output per worker in efficiency units is

(15) $\log(Y / AL)$

$$= \frac{\alpha}{1-\alpha-\eta}\log(s_k) + \frac{\eta}{1-\alpha-\eta}\log(s_h) - \frac{\alpha+\eta}{1-\alpha-\eta}\log(n+g+\delta) \ ,$$

where δ is the common rate of depreciation of physical and human capital, and s_k and s_h are the (constant) fractions of output that are invested in physical and human capital. Substituting equation (15) for *y** in equation (14) results in

(16) $$\log\left(Y(t) / L(t)\right) - \log\left(Y(0) / L(0)\right)$$

$$= gt - \left(1 - e^{-\beta t}\right)\log y(0) - \left(1 - e^{-\beta t}\right)\frac{\alpha+\eta}{1-\alpha-\eta}\log(n+g+\delta)$$

$$+\left(1-e^{-\beta t}\right)\frac{\alpha}{1-\alpha-\eta}\log(s_k)+\left(1-e^{-\beta t}\right)\frac{\eta}{1-\alpha-\eta}\log(s_h)\ ,$$

which allows to account for the impact on the growth rate of alternative rates of factor accumulation. This equation can be further transformed to estimate the impact on growth of alternative *levels* of human capital

(17) $$\log(Y(t)/L(t))-\log(Y(0)/L(0))$$

$$= \ gt-\left(1-e^{-\beta t}\right)\log y(0)-\left(1-e^{-\beta t}\right)\frac{\alpha}{1-\alpha}\log(n+g+\delta)$$

$$+\left(1-e^{-\beta t}\right)\frac{\alpha}{1-\alpha}\log(s_k)+\left(1-e^{-\beta t}\right)\frac{\eta}{1-\alpha}\log(H(t)/L(t))\ ,$$

which differs in terms of the coefficients on the factor inputs from equation (16). Alternatively, using the intensive form of the structural production function (3) rather than the reduced form (15) to substitute for y^* in equation (14), the impact on growth of alternative levels of both factor inputs can be estimated as

(18) $$\log(Y(t)/L(t))-\log(Y(0)/L(0))$$

$$= \ gt-\left(1-e^{-\beta t}\right)\log y(0)$$

$$+\left(1-e^{-\beta t}\right)\alpha\log(K(t)/L(t))+\left(1-e^{-\beta t}\right)\eta\log(H(t)/L(t))\ .$$

Given that the underlying growth theory suggests that the capital-output ratio *K/Y* rather than the capital intensity *K/L* should remain constant in the steady state, *K/L* can be substituted for *K/Y* which results in

(19) $$\log(Y(t)/L(t))-\log(Y(0)/L(0))$$

$$= \ gt-\left(1-e^{-\beta t}\right)\log y(0)$$

$$+\left(1-e^{-\beta t}\right)\frac{\alpha}{(1-\alpha)}\log(K(t)/Y(t))+\left(1-e^{-\beta t}\right)\eta\log(H(t)/L(t)),$$

with a different coefficient on the human capital variable. The next section shows how equations (13), (14), (17), and (19) can be used to derive quantitative estimates of the level and growth effects of convergence by taking into account the empirical evidence presented in Section III on the initial income level, the share of investment in GDP, the amount of capital mobility, the capital-output ratio, and the stock of human capital.[5]

[5] Details of the calculations are available on request in the form of Lotus 1-2-3 worksheets.

V. Level and Growth Effects of Convergence for a Standard Parameterization of Preferences and Technology

1. The Level Effect of Convergence: Present Value of Output Gain

As a first step, I calculate the hypothetical level effect of convergence as graphically shown in Figure 7 and quantitatively defined by equation (13). With an initial East German labor productivity of 30 percent of the West German level, the steady state gap indicated by the last term on the right-hand side of equation (13) equals 233 percent. To identify the real interest rate and the convergence rate required for a calculation of the first and the second term of the right-hand-side of equation (13), a standard parameterization of preferences and technology can be used.

First, the steady-state real interest rate equals the rate of time preference ρ plus the inverse of the intertemporal elasticity of substitution of consumption θ times the rate of labor-augmenting technological change *g*:

(20) $r = \rho + \theta g$.

Barro et al. (1995) derive a real interest rate of 6 percent by assuming that θ equals 2 (so the intertemporal elasticity of substitution equals 0.5), and both ρ and *g* equal 2 percent. This real interest rate appears to fit with long-term averages of real rates of return on the US stock market.

Second, Barro et al. (1995) derive the rate of convergence to the steady state as

(21) $$2\beta = \left\{\varphi^2 + 4\left(\frac{1-\omega}{\theta}\right)(\delta+\rho+\theta g)\left[\frac{\delta+\rho+\theta g}{\omega} - (\delta+n+g)\right]\right\}^{1/2} - \varphi \ ,$$

where ω equals $\alpha+\eta$ for the closed economy and ω equals $\eta/(1-\alpha)$ for the open economy, α is the share of physical capital in factor income and η is the share of human capital in factor income (see also the production function (3)), δ is the depreciation rate of physical and human capital, *n* is the exogenous rate of population growth, and $\varphi = \rho - n - (1-\theta)g > 0$.

The difference between the convergence rates of the open and the closed economy entirely hinges on ω, which reflects the assumption made about the amount of capital that can serve as collateral for external borrowing. Barro et al. (1995) show that the exponent on the broad capital-stock variable including physical and human capital is $\eta/(1-\alpha)$ in the debt-constrained open economy rather than $\alpha+\eta$ in the closed economy.

If all capital constitutes collateral $(\eta = 0,\ \alpha = 1)$, $\omega = 0$ and equation (21) would predict an infinite rate of convergence for an economy with capital stock *k*. This case obviously does not apply in reality if a whole economy is concerned, but it may provide a reasonable explanation for cases like the reconstruction after the Kobe earthquake. If no capital constitutes collateral $(\alpha = 0)$, $\omega = \eta$ and equation (21) would predict the rate of convergence of a closed economy with capital stock *h*. This

case also does not apply for countries which become a member of an economic union with access to the international capital market, as in the case of East Germany. If external borrowing is constrained by the amount of physical capital that can serve as collateral $(\alpha > 0,\ \eta > 0,\ \alpha + \eta < 1)$, $\omega = \eta / (1 - \alpha)$ and equation (21) predicts a convergence rate for an economy with a broad capital stock $h+k$. This intermediate case seems to be most appropriate for assessing East Germany's hypothetical rate of convergence after unification and EU membership, where the amount of net capital inflows comes close to the typical factor share of physical capital in the range of 30 percent.

For a quantitative estimate of the rate of convergence, Barro et al. (1995) use parameter values that seem reasonable for the US economy and other industrialized countries. They assume factor shares of 30 percent for physical capital and 50 percent for human capital based on results by Jorgenson et al. (1987). They further assume a common depreciation rate for physical and human capital of 5 percent and a rate of population growth of 1 percent. The assumptions regarding ρ, θ, and g are the same as in the case of the real interest rate. Based on this parameterization, the convergence rate of the open economy with partial physical capital mobility equals 2.23 percent, which is less than one percentage point above the convergence rate of 1.43 percent of the closed economy. Since the predicted difference between the two convergence rates appears to be rather small, the chosen parameterization reconciles the predictions of the open-economy neoclassical growth model with the empirical evidence on convergence rates for economies with and without capital mobility (see Section II), as would be required for assessing the growth performance of an economy which gained access to an integrated capital market.

Table 1 shows the results for a simulation of the hypothetical output effect of the convergence to the steady state. For the standard parameterization discussed above and a zero growth rate of the population, the model suggests that the present value of the output gain of convergence equals about 11 times the initial level of output (first row). This result shows the large hypothetical output effects of convergence compared to a situation without any convergence. Put differently, the potential benefits of joining an economic union like the EU appear to be large given that is the only option for an economy to establish credible institutions and access to the international capital market.

However, Table 1 also shows that the quantitative finding is sensitive to the assumptions about the distance from the steady state, the degree of capital mobility, and the intertemporal elasticity of substitution (see the following rows). The predicted present value of the output gain of convergence is much larger for countries starting further away from the steady state and it is much smaller for countries starting closer to the steady state. A lower degree of capital mobility, as modeled by a lower share of physical capital in factor income, substantially reduces the predicted present value, while a higher degree of capital mobility represented by the East German trade deficit of about 45 percent (see Figure 4) increases the predicted present value. A lower intertemporal elasticity of substitution, which may be reasonably assumed for relatively poor countries according to work by Ogaki and Atkeson (1997), reduces the predicted

present value.[6] Combining a lower intertemporal elasticity of substitution with the high degree of capital mobility observed for the case of East Germany still suggests that here might be a large long run potential output gain of joining an economic union with credible institutions and access to the world capital market, given that without joining there would be no credible institutions and no capital mobility, and hence no convergence.

Table 1 — Potential Output Effects of Convergence[a]

Initial output level	Capital mobility parameter	Intertemporal elasticity of substitution	Present value of output gain (multiple of initial output level)
y(0)	α	$1/\theta$	$\overline{PV}$
0.3	0.30	½	10.9
0.1	0.30	½	41.9
0.6	0.30	½	3.1
0.3	0.05	½	8.1
0.3	0.45	½	13.6
0.3	0.30	1/3	5.7
0.3	0.45	1/3	7.5

[a]Parameter assumptions: $\rho = 0.02,\ \theta = 2,\ \alpha + \eta = 0.8,\ \delta = 0.05,\ g = 0.02,\ n = 0$.

2. Growth Effects of Absolute and Conditional Convergence

With the large potential long-run level effects of convergence, the question arises which growth effects the underlying model would predict for shorter time periods, such as the first ten years after German unification. Such an exercise can show how close the actual East German growth record comes to the theoretical predictions. Comparing the observed with the predicted growth rates thus provides an answer to the question whether the East German record can be regarded as a success or as a failure up to now.

Equation (14) describes the growth rate of an economy which starts below its steady state. Given that the West German level of output per worker represents the

[6] As shown by Barro et al. (1995), assuming a lower intertemporal elasticity of substitution (a higher θ) implies a lower broad saving rate which includes physical and human capital. If the intertemporal elasticity of substitution equals 0.5, the implied saving rate would equal 36 percent for the standard parameterization of preferences and technology and a marginal tax rate of 30 percent. If the intertemporal elasticity of substitution falls to 0.33, the implied saving rate, ceteris paribus, declines to 30 percent.

relevant steady state for the East German economy, and given that the convergence rate is determined by a standard parameterization of preferences and technology as before, the predicted growth rate follows directly as a function of the initial steady state gap. With initial East German labor productivity at 30 percent of the West German level and a convergence rate of 2.15 percent, the East German economy should have grown on average by 4.3 percent per year relative to the West German economy over the first ten years after unification. In fact, it has grown on average by 6.9 percent per year relative to West Germany since labor productivity doubled from 30 to 60 percent of the West German level (Table 2, first row).[7] Such a positive assessment of the actual East German growth record does not change by much if the high amount of capital inflows is taken into account by assuming a factor share of physical capital of 45 percent (rather than 30 percent) in the calculation of the convergence rate. The convergence rate rises to 3 percent (not shown) and the predicted growth rate is now 5.1 percent, which is still substantially below the observed growth rate of 6.9 percent.

Table 2 — Growth Effects of Absolute Convergence[a]

Initial labor productivity	Time period (years)	Capital mobility parameter	Predicted growth rate (percent)	Actual growth rate (percent)
Y / L	t	α		
0.3	10	0.30	4.3	6.9
0.3	10	0.45	5.1	6.9
0.5	7	0.30	3.4	2.6
0.5	7	0.45	3.9	2.6

[a]Parameter assumptions: $\rho = 0.02,\ \theta = 2,\ \alpha + \eta = 0.8,\ \delta = 0.05,\ g = 0.02,\ n = 0$.

The problem is that most of the East German catching up happened in the very first years after unification. For instance, the East German economy reached 50 percent of the West German level of labor productivity as soon as 1993. Hence considering the growth record since 1993 provides a very different picture. The model would predict an average annual growth rate of 3.4 percent for the first seven years after the economy starts from a level of labor productivity which is 50 percent of its steady state level. Taking account of the high capital imports, the predicted average annual growth rate would rise to 3.9 percent. But the East German economy has only grown by 2.6 percent on average in 1993-2000 (Table 2). So ignoring the first years of unification, the model

[7] In the following calculations, I assume for convenience that East German labor productivity equals 60 percent of the West German level in 2000. The actual figure may turn out to be somewhat lower.

would suggest a disappointing growth and convergence record of the East German economy.

An alternative interpretation would be to assume that the East German economy converges to its own steady state, which could differ from the West German productivity level as it may reflect a different set of preferences that are inherited from 40 years of socialist planning. Hence this kind of conditional convergence may be a more appropriate concept for the short and medium run than the concept of absolute convergence as discussed before. Equations (17) and (19) can be used to implement the concept of conditional convergence for the case of the East German economy.

Section III has shown that investment as a share of GDP is about as twice as high and that the aggregate capital-output ratio is about 1.3 times (and the manufacturing capital-output ratio is about 3 times) higher in East Germany than in West Germany, whereas the empirical evidence for the relative stock of human capital appears to be inconclusive. Table 3 shows the results for the predicted average annual growth rates (relative to West Germany), if the model economy starts at 50 percent of its own steady state, which is determined by a higher investment share (first two lines of Table 3) or alternatively by a higher capital-output ratio (relative to West Germany) as reported in Section III. These results have to be compared with the actual East German growth rate of output per worker, which was 2.6 percent per year in 1993-2000.

Table 3 — Growth Effects of Conditional Convergence[a]

Initial labor productivity	Time period (years)	Capital mobility parameter	Investment share	Capital-output ratio	Predicted growth rate (percent)
Y / L	t	α	*I/GDP*	*K/Y*	
0.5	7	0.30	2	-	4.0
0.5	7	0.45	2	-	4.6
0.5	7	0.30	-	1.3	3.6
0.5	7	0.45	-	1.3	4.2
0.5	7	0.30	-	3	4.3
0.5	7	0.45	-	3	5.1

[a]Parameter assumptions: $\rho = 0.02,\ \theta = 2,\ \alpha + \eta = 0.8,\ \delta = 0.05,\ g = 0.02,\ n = 0$.

In Table 3, the difference between the predicted growth rate and the actual growth rate of 2.6 percent is larger than in Table 2. This simply follows from the logic of the model which predicts that an economy with a higher sustainable investment share and hence with a higher long-run capital-output ratio should, all other things constant, display a higher average growth rate up to the steady state, especially in the short run.

Hence assuming a lower relative East German stock of human capital, despite fairly high levels of formal schooling and other formal training as noted in Section III, emerges as the most obvious possibility to reconcile the predicted and the actual growth rates.

Table 4 uses two ad hoc specifications of the relative East German stock of human capital to simulate the predicted growth rate of a model economy starting from 50 percent of its steady-state level of labor productivity. Setting East Germany's stock of human capital per worker to 50 percent of the West German level (H/L=0.5) apparently does not suffice to reconcile the predicted growth rate with the observed growth rate for the parameterizations and specifications considered. But the model predicts a growth rate close to 2.6 percent for 1993-2000 if the East German stock of human capital is set to 30 percent of the West German level (H/L=0.3), given that either the East German investment share is hundred percent higher (I/GDP=2) or the East German capital-output ratio is 30 percent higher (K/Y=1.3) than in West Germany.

Table 4 — The Impact of Alternative Human Capital Stocks on the Growth Effect of Convergence[a]

Initial labor productivity	Time period (years)	Capital mobility parameter	Human capital stock	Investment share	Capital-output ratio	Predicted growth rate (percent)
Y / L	t	α	H/L	I/GDP	K/Y	
0.5	7	0.45	0.5	2	-	3.3
0.5	7	0.45	0.3	2	-	2.4
0.5	7	0.45	0.5	-	1.3	3.2
0.5	7	0.45	0.3	-	1.3	2.5

[a]Parameter assumptions: $\rho = 0.02,\ \theta = 2,\ \alpha + \eta = 0.8,\ \delta = 0.05,\ g = 0.02,\ n = 0$.

Taking this model result at face value, the East German economy would be predicted to reach a steady state below the West German level. This follows by solving equation (7) for the difference between the steady state and initial income as

$$\log y^* - \log y(0) = \frac{\log Y(t) / L(t) - \log Y(0) / L(0) - \left(\log A(t) - \log A(0)\right)}{1 - e^{-\beta t}} \quad , \tag{22}$$

which equals 0.3 with $Y(t) / L(t) = 0.6$, $Y(0) / L(0) = 0.5$, and the standard parameterization of preferences and technology as used before.

With initial labor productivity at 50 percent, the model predicts an East German steady state of output per worker at about two thirds of the West German level $\left[y^* = e^{0.3} \cdot y(0) = 1.35 \cdot y(0)\right]$. Future empirical research will have to prove whether

these theoretical simulations, which are based on an implied lower East German stock of human capital, bear any empirical significance. For the time being, they may be considered as a reminder not to confuse the average level of formal schooling and training of the workforce with a measure of the economically relevant stock of human capital.

VI. Investing in Human Capital Through Worker Retraining Programs?

Taking the simulation results of the previous section at face value, investing in human capital appears to be an obvious policy response for the East German economy to reach a higher level of output per worker. Improving the quality of schooling should be an appropriate long-run strategy, not only in East Germany. But according to recent empirical studies (Gundlach et al. 2001, Wößmann 2001), it remains questionable whether such an end could actually be achieved by means of higher public expenditures on schooling. Yet policymakers face an even more difficult question, namely how the stock of human capital can be raised in the short run. Up to now, the answer has been a to provide publicly funded worker retraining programs. These programs aim at reducing the high level of structural unemployment in East Germany, which mainly reflects the lack of human capital per worker at the prevailing level of wages.

Previous worker retraining measures in European countries and elsewhere have generally not been found to produce significant positive effects (Heckman et al. 1999, Martin 1998). In line with these research results, the more recent East German experience also questions the presumed net social benefits of worker retraining measures. Such a dismal assessment should be a matter for concern just because many European countries spend fairly large amounts of resources on active labor market programs. For instance in 1996, the average EU country spent 1.2 percent of GDP on active labor market measures, which is more than twice as much as in countries like Japan or the United States (Martin 1998). Public spending on active labor market measures per unemployed person reached up to 30 percent of average output per worker in Denmark and Sweden in 1996, compared to about 10 percent in the average EU country. A similar picture emerges when the total number of persons engaged in labor market measures is considered. About ten percent of the labor force in the average EU country participated in active labor market measures in 1996. Within these measures, worker retraining programs account for the largest share of active spending measures in the average EU country (28 percent in 1996). Given these large resource flows, questions are whether participants actually benefited from training programs and whether these programs are worthwhile social investments.

In principle, retraining measures can improve and enhance the human capital of workers and thereby raise their re-employment chances and their future wages. In the context of a growth-theoretic framework, such measures could help to establish a higher steady state level and hence a higher growth rate until the steady state is reached. Retraining measures can also help to adjust the quality of existing labor supply to structural changes in labor demand caused by new technologies and increased competition on world markets, as in the case of East Germany after unification.

In practice, however, publicly funded retraining measures may not only have positive effects. Future employers may understand participation in a retraining program

as a signal of low worker productivity, or retraining may actually downgrade the qualification of workers as compared to their previous level of human capital. Another possibility is that re-employment of trained workers may only substitute for previously employed workers, leaving the total level of unemployment unchanged.

Unfortunately, labor market programs in European OECD countries have been rarely evaluated rigorously in the past. One reason for the lack of large-scale evidence may be that in Western Europe, government assistance in retraining is often viewed as something similar to a fundamental right which defies economic analysis. Another reason may be that labor market programs often serve short run political purposes and evaluations confirming their economic ineffectiveness are not welcomed by government officials (Martin 1998). What follows summarizes some new evidence that comes from labor retraining programs initiated to mitigate the rise in structural unemployment in East Germany after unification.

The main point to note in any evaluation of worker retraining is that the effects of a specific measure can only be clearly identified if there is a control group of workers which did not receive training, but is otherwise identical to the group of workers which did receive training. The difference in re-employment probabilities and wages could then be ascribed to the specific training measure imposed. Without such a setting, results necessarily remain ambiguous.

Many studies, especially in European countries, evaluate the success of a retraining measure without comparing the presumed employment and wage effects with those of a control group of workers and can, therefore, hardly be considered as representing convincing evidence. Other so-called quasi-experimental studies select treatment and control groups after the retraining measure was implemented and use statistical techniques to control for differences in the characteristics of the two groups compared. Despite their statistical complexity, such studies provide more reliable estimates of the effectiveness of worker retraining. This is because at least in principle, they can identify the change in re-employment probabilities and wages that is due only to the training measure imposed, and not to other factors.

In East Germany, more than 50 percent of all working-age persons participated in worker retraining measures in 1989-1994 (Hübler 1997). Yet the East German experience with worker retraining measures paints a dismal picture. Spending on worker retraining was extremely high by historical and by international standards, but the employment and especially the wage effects appear to be close to zero and may in some cases even be negative. This assessment is based on the findings of several studies which rely on advanced microeconometric methods to address the selectivity problem. That is, these studies measure wage and employment effects of retraining measures relative to wage and employment effects of otherwise identical workers which did not receive training.[8] For instance,

[8] These studies use data from two sources. One is the German Socio Economic Panel (GSEP). Since 1990, the GSEP includes a sample of just under 2000 East German households. The other is the so-called Labor Market Monitor (LMM), which is a mail survey conducted every 4 to 6 months. The number of observations is higher in the LMM than in the GSEP, but the LMM lacks the variables needed for nonparametrically identifying the effects of training measures and hence requires specific modeling strategies.

- Hübler (1997) finds negative short run employment effects of retraining, and small positive effects for men only in the longer run (without considering possible replacement effects and the implied return on the investment measures). For women, however, training measures only appear to precede becoming unemployed.
- Fitzenberger and Prey (1997) find that in contrast to on-the-job training, public training measures do not generate statistically significant effects.
- Kraus et al. (1999) find that in the first phase of the East German transition process, when the institutions that delivered the training programs were set up, there were no positive effects of training on re-employment probabilities; small positive employment effects appear to show up only after the institutional structure of the programs was in place.
- Lechner (1999) finds that vocational training and retraining measures have a negative impact on re-employment probabilities in the short run, probably because participants reduced job search efforts as compared to non-participants; he finds no significant effects several months after the training measure.

These by and large negative results are all the more remarkable because the trainees in East Germany did not come from the low-skill-low-ability group which is the target of many programs in other countries. By contrast, program participants in East Germany were in general well educated and had fairly high job positions in the former German Democratic Republic (GDR). These features again confirm the hypothesis that the average level of formal schooling and training should not be confused with a measure of the economically relevant stock of human capital.

Overall, the East German evidence on worker retraining measures suggests that it will remain extremely difficult to design effective public training programs. But even if it were possible to generate an effective retraining program at least for a certain group of workers, policy makers should be aware that any program is unlikely to raise average annual income for a substantial number of people. The empirical literature suggests that a rate of return of investment in human capital through training measures of about 10 percent would be considered as high. That is, a thousand Euros spend on the retraining of an unemployed worker would not raise her income by more than 100 Euros. Given the limited resources available for retraining measures, and given that the return to training measures is most likely to be substantially lower than 10 percent in practice, the absolute effects on the steady-state level of labor productivity that can be achieved by worker retraining measures appear to be limited.

Moreover, more rigorous econometric evaluations indicate that job search assistance measures appear equally effective and costless than half of worker retraining measures. This does not change the insight that any labor market measure is unlikely to raise the steady state by a substantial amount, but it points to possible priorities where to invest available public funds.

An important weakness of most existing studies is their microeconomic focus. As such, they do not take into account that retraining measures have to be financed by higher taxes and that retrained workers may simply displace employed workers. With these macroeconomic repercussions on labor demand in mind, the *social* benefits of

retraining measures would be considerably lower than the private benefits indicated by otherwise scientifically valid evaluations.

Therefore, it seems that worker retraining measures will not suffice to achieve a higher East German steady state. All available empirical evidence suggests that the human capital of workers cannot be easily adapted to changing economic circumstances, not even by costly retraining measures. Especially those retraining measures that focus on older workers are bound to fail economically, and can only be motivated for political reasons. Investing in human capital through effective schooling of the young, and especially the very young, may prove to be a superior policy alternative. The reason is quite simple: for the same level of investment at each age, the return from spending on the young is higher because the old have a shorter working life to recoup the investment made. For the case of East Germany, this insight means that convergence of labor productivity to the West German level, if it evolves at all, is more likely to take generations than decades, not to speak of the single decade that was envisaged by some commentators early after unification.

References

Barbone, Luca, Juan Zalduendo (1997). EU Accession of Central and Eastern Europe: Bridging the Income Gap. The World Bank, Policy Research Working Paper, 1721, February.

Barrell, Ray, Dirk Willem te Velde (2000). Catching Up of East German Labour Productivity in the 1990s. German Economic Review 1: 271-297.

Barro, Robert J., Jong-Wha Lee (2000). International Data on Educational Attainment: Updates and Implications. NBER Working Paper, 7911, September.

Barro, Robert J., N. Gregory Mankiw, Xavier Sala-i-Martin (1995). Capital Mobility in Neoclassical Models of Growth. American Economic Review 85 (1): 103-115.

Barro, Robert J., Xavier Sala-i-Martin (1991). Convergence across States and Regions. Brookings Papers on Economic Activity (1): 107-158.

Barro, Robert J., Xavier Sala-i-Martin (1992). Convergence. Journal of Political Economy 100: 223-251.

Boltho, Andrea, Wendy Carlin, Pasquale Scaramozzino (1997). Will East Germany Become a New Mezzogiorno? Journal of Comparative Economics 24: 241-264.

Deutsches Institut für Wirtschaftsforschung (DIW) (1995). Nach wie vor große Defizite beim ostdeutschen Kapitalstock. Wochenbericht 62 (35): 535-544.

Deutsches Institut für Wirtschaftsforschung (DIW), Institut für Wirtschaftsforschung Halle, Institut für Weltwirtschaft an der Universität Kiel (1999). Gesamtwirtschaftliche und unternehmerische Anpassungsfortschritte in Ostdeutschland. Kiel Discussion Papers, 346/347, June.

Dornbusch, Rudiger, Holger Wolf (1992). Economic Transition in East Germany. Brookings Papers on Economic Activity (1): 235-261.

Fischer, Stanley, Ratna Sahay (2000). The Transition Economies After Ten Years. NBER, Working Paper, 7664, April.

Fitzenberger, Bernd, Hedwig Prey (1997). Assessing the Impact of Training on Employment: The Case of East Germany. IFO Studien 43: 71-116.

Funke, Michael, Holger Strulik (2000). Growth and Convergence in a Two-Region Model of Unified Germany. German Economic Review 1: 363-384.

Giersch, Herbert, Karl-Heinz Paqué, Holger Schmieding (1992). The Fading Miracle: Four Decades of Market Economy in Germany. Cambridge.

Gundlach, Erich (1993). Empirical Evidence for Alternative Growth Models: Time Series Results. Weltwirtschaftliches Archiv 129: 103-119.

Gundlach, Erich, Markus Diehl (1999). Capital Mobility and Growth. Economics Letters, 62: 131-133.

Gundlach, Erich, Desmond Rudman, Ludger Wößmann (forthcoming). Second Thoughts on Development Accounting. Applied Economics.

Gundlach, Erich, Ludger Wößmann, Jens Gmelin (2001). The Decline of Schooling Productivity in OECD Countries. Economic Journal, 111 (May): C135-C147.

Hall, Robert E., Charles I. Jones (1999). Why Do Some Countries Produce So Much More Output per Worker than Others? Quarterly Journal of Economics 114: 83-116.

Heckman, James J., Robert J. Lalonde, Jeffrey A. Smith (1999). The Economics and Econometrics of Active Labor Market Programs. In: Orley Ashenfelter, David Card (eds.), Handbook of Labor Economics, Vol. 3, Amsterdam: 1865-2097.

Horwich, Geoge (2000). Economic Lessons of the Kobe Earthquake. Economic Development and Cultural Change 48: 521-542.

Hübler, Olaf (1997). Evaluation beschäftigungspolitischer Maßnahmen in Ostdeutschland. Jahrbücher für Nationalökonomie und Statistik 216: 21-44.

Hughes Hallet, Andrew J., Yue Ma (1993). East Germany, West Germany, and Their Mezzogiorno Problem: A Parable for European Economic Integration. Economic Journal 103 (March): 416-428.

Hunt, Jennifer (2000). Why Do People Still Live in East Germany? NBER Working Paper, 7564, February.

Jones, Charles I. (1995). R&D-Based Models of Economic Growth. Journal of Political Economy 103:759-784.

Jones, Charles I. (1997). Population and Ideas: A Theory of Endogenous Growth. NBER Working Paper, 6285, November.

Jorgenson, Dale W., Frank Gollop, Barbara Fraumeni (1987). Productivity and U.S. Economic Growth. Amsterdam.

Keller, Wolfgang (2000). From Socialist Showcase to Mezzogiorno? Lessons on the Role of Technical Change from East Germany's Post-World War II Growth Performance. Journal of Economic Development 63: 485-514.

Klenow, Peter J., Andrés Rodriguez-Clare (1997). The Neoclassical Revival in Growth Economics: Has it Gone Too Far? NBER Macroeconomics Annual 12: 73-102.1

Klodt, Henning (2000). Industrial Policy and the East German Productivity Puzzle. German Economic Review 1: 315-333.

Kraus, Florian, Patrick A. Puhani, Viktor Steiner (1999). Employment Effects of Publicly Financed Training Programs: The East German Experience. Jahrbücher für Nationalökonomie und Statistik 219 (1/2): 216-248.

Lechner, Michael (1999). An Evaluation of Public-Sector-Sponsored Continuous Vocational Training Programs in East Germany. University of St. Gallen, Department of Economics, Discussion Paper, 9901, January.

Lucas, Robert E., jr. (1988). On the Mechanics of Economic Development. Journal of Monetary Economics 22: 3-42.

Mankiw, N. Gregory, David Romer, David N. Weil (1992). A Contribution to the Empirics of Growth. Quarterly Journal of Economics 107: 408-437.

Martin, John P. (1998). What Works Among Active Labor Market Policies: Evidence from OECD Countries' Experience. OECD, Labor Market and Social Policy-Occasional Papers, 35. Paris.

Ogaki, Masao, Andrew Atkeson (1997). Rate of Time Preference, Intertemporal Elasticity of Substitution, and Level of Wealth. Review of Economics and Statistics 79: 564-572.

Prescott, Edward C. (1998). Needed: A Theory of Total Factor Productivity. International Economic Review 39: 525-552.

Ragnitz, Joachim (1999). Warum ist die Produktivität ostdeutscher Unternehmen so gering? Konjunkturpolitik 45 (3): 165-187.

Romer, Paul (1989). Capital Accumulation in the Theory of Long-Run Growth. In. Robert J. Barro (Ed.), Modern Business Cycle Theory. Cambridge MA: 51-127.

Sala-i-Martin, Xavier (1996). The Classical Approach to Convergence Analysis. Economic Journal 106: 1019-1036.

Sheshinski, Eytan (1997). Growth Theory in the 60s and the 90s. Paper presented at the Symposium In Memory of Michael Bruno, mimeo.

Sinn, Hans-Werner (2000). Germany's Economic Unification: An Assessment After Ten Years. NBER Working Paper, 7586, March.

Sinn, Hans-Werner, Frank Westermann (2001). Two Mezzogiornos. NBER Working Paper, 8125, February.

Solow, Robert M. (1956). A Contribution to the Theory of Economic Growth. Quarterly Journal of Economics 70: 65-94.

Solow, Robert M. (1994). Perspectives on Growth Theory. Journal of Economic Perspectives 8: 45-54.

Summers, Robert, Alan Heston (1984). Improved International Comparisons of Real Product and Its Composition: 1950-80. Review of Income and Wealth 30 (2): 207-262.

Topel, Robert (1999). Labor Markets and Economic Growth. In: Orley Ashenfelter, David Card (Eds.), Handbook of Labor Economics. Vol. 3 C, Amsterdam.

Wagner, Karin (1993). Qualifikationsniveau in ostdeutschen Betrieben. Zeitschrift für Betriebswirtschaft 63 (2): 129-145.

Wößmann, Ludger (2001). Why Students in Some Countries Do Better. *Education Matters* 1 (2): 67-74.

World Bank (2000). World Development Indicators. CD-ROM.