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ELINKEINOELÄMÄN TUTKIMUSLAITOS
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
Lönnrotinkatu 4 B 00120 Helsinki Finland Tel. 358-9-609 900
Telefax 358-9-601 753 World Wide Web: http://www.etla.fi/

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Ville Kaitila – Kari E.O. Alho – Nuutti Nikula

GROWTH PROSPECTS OF EMERGING MARKET ECONOMIES IN EUROPE – HOW FAST WILL THEY CATCH UP WITH THE OLD WEST?

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ABSTRACT: Using a neo-classical growth model, we analyse the real and nominal GDP per capita convergence of 21 emerging market economies (EMEs) of Central and Eastern Europe towards the EU15 average by 2050. We estimate the countries' initial capital stocks and project future investment as a function of the GDP per capita gap, among other things, in order to have converging physical capital intensities in the long run. Due to standard β-convergence in the model, catching up will continue at a decelerating speed. Also nominal convergence in prices that will lead to a real appreciation of the EME currencies with respect to the euro is projected as a function of the GDP-per-capita gap vis-à-vis the EU15. We also discuss whether the level of human capital in the EMEs is likely to allow for full catching up. We argue that the EU membership of most of the EMEs is likely to improve their economic, investment and business environments and lead to economic and other policies that support long-term convergence. According to the results, the EMEs will not quite catch up with the EU15 by 2050. However, our analysis of the uncertainty related to the growth rates and calculations of a confidence band for the results, as well as a qualitative assessment of other factors (politics, institutions, human capital) that have not been taken into account in the model explicitly lead us to conclude that some of the EMEs are likely to catch up with the EU15 average during the course of the next couple of decades.

KEY WORDS: Productivity, growth, convergence, emerging markets, EU

JEL codes: O47

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TIIVISTELMÄ: Tässä tutkimuksessa analysoidaan uusklassisella kasvumallilla 21:n Keski- ja Itä-Euroopan (KIE) kehittyvän markkinatalousmaan kasvunäkymiä kohti EU15-maiden reaalista ja nimellistä tulotasoa vuoteen 2050 asti. Estimoimme lähtöhetken pääomakannan eri maissa ja oletamme, että investointikehitys tulevaisuudessa riippuu mm. tulotasoerosta EU15-maihin. Näin maiden pääomaintensiivisyys konvergoituu pitkällä aikavälillä. Standardista β-konvergenssista seuraa, että tulotasojen lähentyminen jatkuu hidastuvasti. Myös KIE-maiden valuuttakurssien vahvistumiseen euron suhteen johtavan hintatasojen konvergenssin oletetaan riippuvan tulotasoerosta. Arvioimme lisäksi sitä, onko KIE-maiden koulutuksen taso riittävä EU15:n kiinniottamiseksi. EU-jäsenyyden, joka useimmilla KIE-mailla on, voidaan odottaa tukevan maiden investointi- ja yritysilmapiiriä ja johtavan sellaisen talous- ja muun politiikan harjoittamiseen, joka tukee konvergenssia pitkällä aikavälillä. Tulosten mukaan KIE-maat eivät saa EU15-maita kiinni vuoteen 2050 mennessä. Jos tulokset kuitenkin yhdistetään analyysiimme kasvuvauhdin epävarmuudesta ja laskelmiin tulosten luottamusvälistä sekä kvalitatiiviseen arvioon muista tekijöistä (politiikka, instituutiot, koulutustaso), joita ei ole otettu kasvumallissa eksplisiittisesti huomioon, voidaan argumentoida, että jotkin KIE-maat todennäköisesti saavuttavat EU15-maiden keskimääräisen tulotason muutaman seuraavan vuosikymmenen aikana.

AVAINSANAT: Tuottavuus, kasvu, konvergenssi, kehittyvät taloudet, EU

JEL-koodit: O47

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Catching up with the EU15

For more than a decade the emerging market economies (EMEs) in Central and Eastern Europe have, for the most part, been growing faster than the wealthier EU15 countries. Thus they have been catching up in terms of GDP per capita. We analyse the growth performance of 21 emerging market economies[1] from the 1990s onwards and make projections of their growth prospects up to 2050.

Currently, Slovenia is the wealthiest of the EMEs with a purchasing-power (PPP) adjusted GDP per capita equal to 77 per cent of the EU15 average. In market prices, Slovenia's GDP per capita is 53 per cent of the EU15 average. Georgia is the poorest of the EMEs with respective GDP per capita levels of 13 and 5 per cent of the EU15 average. The differences between the EMEs are thus very large.

The framework for the growth projections

We construct a neo-classical growth model to project trend volume growth of purchasing-power adjusted GDP in the EMEs and the EU15 into the future. Using historical data we estimate current capital stocks and future investment rates which will converge in time with those in the EU15. We also take into account nominal convergence in prices which will lead to a real appreciation of the EMEs' currencies. Combining these two we get convergence in GDP per capita in market prices.

Following the standard β-convergence feature of recent growth literature, the model is constructed so that the speed of convergence will slow down as the gap in GDP per capita between the EMEs and EU15 decreases. The investment rate plays a relatively limited role in the long run, while total factor productivity growth and population developments play a larger one. The projections presume continuing reforms and development that are supportive of a business-friendly environment as well as stable democratic institutions.

We also demonstrate the uncertainty related to long-term growth projections, discuss the possible effects of human capital accumulation on the rate of convergence, examine the importance of energy commodities for some of the EMEs, and project the future development in the real rate of return on capital based on our growth model. Also political and institutional factors are important for the countries' growth prospects. As usual, there is great uncertainty related to such long-term growth projections. Convergence is not automatic as global economic history very clearly demonstrates.

Total GDP projected to rise from 37 per cent to 81 per cent of EU15 total by 2050

Despite an almost equal total population in the EMEs and the EU15, the total purchasing-power adjusted GDP in the 21 EMEs is currently 37 per cent of that in the EU15 and just 17 per cent when measured in market prices. We project the EU15 economy to grow at an average real rate of 1.9 per cent between 2006 and 2050, and the EMEs to grow at an average real rate of 3.7 per cent. In addition to this the EMEs' average real exchange rate is projected to appreciate by a total of 84 per cent. Thus relative to the EU15 total, GDP in the EMEs is projected to grow to 81 per cent in PPP-terms and to 69 per cent in market prices by 2050.

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[1] The countries analysed are Albania, Armenia, Azerbaijan, Bosnia-Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Latvia, Lithuania, Macedonia, Poland, Romania, Russia, Slovakia, Slovenia, Turkey and Ukraine. These are all transition countries apart form Turkey which is thus the only not formerly socialist country.

The change is very considerable: Adjusting for PPPs, the total real GDP of the 21 EMEs is projected to grow 4.9 fold by 2050. Taking into account projected real exchange rate appreciation, GDP will grow 9-fold its current level.

In per capita terms, we project faster convergence: adjusted for purchasing power from a current 36 per cent to 87 per cent of the EU15 average, and in market prices from a current 16 per cent to 73 per cent in 2050. Thus the projection does not foresee full catching up with respect to the EU15 during this time period.

Weaker projected population growth in the EMEs on average is one important factor causing this. For example, if the future population development of Estonia is as projected by the Eurostat, but we fix the labour-to-population ratio to current level, Estonia will reach the PPP-adjusted GDP per capita of the EU15 in 2047 instead of reaching a projected level of 94 per cent and then actually starting a slow descent.

These projections are subject to a political and institutional environment in the EMEs that will support economic growth. EU membership can be expected to support such developments. Some of the EMEs cannot be expected to join the EU in the future and this poses a negative risk for these countries growth projections.

Top incomes in 2050 projected for the Baltic countries, Russia, Hungary and Slovenia

We project the EMEs on average to reach the current PPP-adjusted GDP per capita of the EU15 countries in real terms in 2028. At that time, they will still be at just 68 per cent of the then EU15 average, and convergence will continue.

Lithuania, Estonia, Hungary, Slovenia, Russia and Latvia will exceed 90 per cent of the EU15 PPP-adjusted GDP per capita by 2050. Estonia is projected to be the first one to do this in 2033. On the other hand, Bosnia-Herzegovina, Albania and Armenia are projected to be at 79 per cent and Georgia at 71 per cent of the EU15 average per capita GDP in 2050.

Population trends very diverging in the EMEs

According to the Eurostat and the US Census Bureau, average population growth is expected to be less favourable in the EMEs than in the EU15. However, expected population growth in the EMEs varies a lot depending on the country. By 2050, total population is expected to have declined from its current level in all but Azerbaijan, Turkey and Albania. The steepest declines will be in Romania, Russia, Ukraine and Bulgaria. The differences are huge: Azerbaijan's population is expected to grow by 23 per cent, while that of Bulgaria will decrease by 34 per cent. Consequently, despite strong projected per capita income growth, Russia's share in the total GDP of the 21 EMEs is projected to decline from the current 37 per cent to 32 per cent by 2050 and that of Turkey to rise from 15 to 23 per cent.

Uncertainty in the projections

If volatility in future GDP growth rates is the same as amongst the EU15 countries in the past, the projection for PPP-adjusted GDP per capita in the EMEs on average in 2050 is 87 per cent of the EU15 average ± 13 percentage points with a probability of 95 per cent. If volatility in growth rates is twice as high in the EMEs as it is in the EU15 countries, the band increases to ± 21 percentage points.

Initially higher rates of return on capital than in the EU15

We project the rate of return on capital in the whole economy as a function of the level of total factor productivity, and the capital-to-labour ratio. Without taking into account taxation, among other things, the average real rate of return on capital in the EU15 is stable at 10.5 per cent. In the EMEs, the rate of return is at first higher than this. As convergence proceeds it

will decline towards the EU15 level. In the EMEs on average, the real rate of return on capital is at first above 14 per cent from where it is projected to decline to 12.5 per cent by 2030 and 10.8 per cent by 2050. Higher rates of return increase yields on investment opportunities. We project higher average investment rates in the EMEs than in the EU15.

Human capital has an effect on growth rate projections

We discuss, but do not model explicitly, the effect of human capital accumulation (education) on growth and convergence. Growth in human capital is in fact incorporated into the overall TFP rise in the model. As countries catch up with high-productivity countries, they will need an ever more educated labour force to continue the catching-up process. Otherwise they may get stuck at a lower relative level of GDP per capita.

Based on available statistics we argue that unless more focus is put on education, the speed of income convergence projected in this study may be to be too high for Albania, Macedonia and Turkey. However, the situation is also concerning in terms of secondary education in Georgia and possibly in Romania and in terms of tertiary education in Armenia, Croatia, the Czech Republic, Romania and Slovakia. In view of the projections, the EMEs still have ample time to invest in education.

Specific upside and downside risks: Oil and politics

Another factor that is not explicitly modelled is the energy commodity dependence of Russia, Kazakhstan and Azerbaijan. During the past several years world market price developments for energy commodities have been very favourable for producer countries. If prices remain high and rising, favourable economic development will continue. On the other hand, the longer this development continues the more likely it is to lead to too rapid real appreciation of these countries' currencies and thus to a deterioration in the competitiveness of their manufacturing industries. According to available estimates, the reserves of crude oil in Russia and Azerbaijan may be exhausted during the time span of our projections. These three countries risk higher real exchange rate volatility than the other EMEs. This would also be reflected in GDP growth rates making them more volatile. However, estimates of the reserves are uncertain.

We also have to recognise that there may be political and institutional risks. These can be expected to be higher in those EMEs that are not, and probably will not, become EU countries. Which countries will eventually join the EU that would provide them with a stable legal, institutional and democratic framework is of course unknown at this point. This negative long-run risk may concern Armenia, Azerbaijan, Georgia, Kazakhstan, Russia, Turkey and Ukraine. Continuing economic and institutional reforms would decrease these risks.

* * *

Although the EMEs are not projected to quite catch up with the EU15 by 2050, the development means that economic weight in Europe will become more evenly distributed, foreign trade will grow and trading patterns will change. This is subject to business-friendly policies in the EMEs. This development will also help in slowing down the decline of the economic weight of Europe in the world economy. The EU15 countries, too, will benefit from successful economic policies in the EMEs, their increasing purchasing power and the political stability that wealth usually brings.

1 INTRODUCTION

The economic transition of the formerly socialist Central and Eastern European countries towards becoming market economies started almost two decades ago. We refer to these countries as emerging market economies or EMEs in this study. During the early years of transition they first experienced a decline in production because their economies were not internationally competitive and because administratively set relative prices in the EMEs differed from those in the international markets and this had distorted their economic structures. After the initial decline which lasted between a couple of years and a decade depending on the country and local conditions, these countries' economies have typically been growing faster than those of the more advanced EU15 countries.

Faster growth in the EMEs has been a result of economic, political and social reforms, economic restructuring with old inefficient plants and factories largely shutting down, and inflows of foreign direct investment (FDI) from more advanced countries in West Europe, North America and East Asia resulting in a rebirth of manufacturing industry as well as many service industries. FDI has brought in modern production technology and modern business management techniques that have boosted productivity growth in the EMEs that would otherwise mostly not have had the domestic financial and human capital to make these investments. In a few countries also the considerable rise in the world market prices of raw materials, namely crude oil, after the late 1990s has been instrumental in supporting growth.

It is likely that the emerging market economies of Central and Eastern Europe will continue to grow faster than the EU15 countries and thus converge in terms of gross domestic product (GDP) per capita towards the future income levels in West Europe. In this study, we make a projection of GDP and GDP per capita growth in 21 countries of Central and Eastern Europe. These are all formerly socialist countries apart from Turkey. The countries analysed are Albania, Armenia, Azerbaijan, Bosnia-Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Latvia, Lithuania, Macedonia, Poland, Romania, Russia, Slovakia, Slovenia, Turkey and Ukraine. The time span of the projection is 2006-2050.

We analyse both real GDP convergence and nominal convergence of prices that will lead to a real appreciation of the EMEs' currencies. The combination of real and nominal convergence gives us projections of future GDP in market prices. For real GDP growth we construct a growth model using the Cobb-Douglas production function. We also show the uncertainty related to convergence. Real GDP convergence comes largely from faster productivity growth in the EMEs than in the EU15 countries. We also discuss, but do not model explicitly, the level of human capital in the EMEs and how this may affect the speed of convergence. A study such as this one does not have the aim of taking into account business cycles. Rather, the projections show estimated trend growth paths.

In Section 2 we will review the starting point of the EMEs in terms of GDP per capita in both purchasing-power adjusted (PPP) terms and market prices. There are considerable differences in these countries' current income levels but they all have room to converge on the EU15.

Section 3 shows the results we get from the growth framework that is constructed in Sections 4 (real convergence) and 5 (nominal convergence). Real GDP growth is calculated on the basis of a PPP-adjusted GDP volume series in 2005 prices. Nominal convergence is calculated by taking GDP in market prices in 2005 and adding the calculated volume change and real exchange rate appreciation.

Figure 1.1 Map of the region: EU15 and the EMEs

Section 6 discusses uncertainty in such growth projections first with examples of historical long-run growth experience of different countries, and then by showing an estimate of the average cumulative uncertainty related to our long-run growth projections. We also show how the results would change if we were to change some of the assumptions that we have made.

Section 7 offers a discussion of some special factors that have not been possible to include in the numerical projections and an assessment of how these factors could affect the results in the long run. We discuss how relevant our measurement of labour is and what importance the level of human capital, i.e. education, could play in our results. After these we discuss the role of crude oil and natural gas for Russia, Azerbaijan and Kazakhstan, which rely heavily on these commodities in their exports but which, according to international estimates, may be running partly out of their reserves of crude oil before our projection period ends.

In Section 8 we analyse the expected development in the pre-tax real rate of return on capital in the EMEs and also whether the growth projections can give any indication of the future value of market capitalisation in these countries.

Our model is such that convergence *will* take place. It should be emphasised, however, that while we expect the EMEs on average to converge towards the EU15 in terms of GDP per capita, it is quite probable that some of them will never reach the EU15 levels and may even get stuck at considerably lower relative income levels. Convergence is not automatic as global economic history very clearly demonstrates. There is considerable uncertainty related to long-term GDP growth projections.

2 THE STARTING POINT

In 2005, the EMEs' total purchasing-power (PPP) adjusted GDP in current prices was 36 per cent of the EU15 total. The EMEs' total population is 5 per cent larger than the EU15 population. Thus relative GDP per capita was about 34 per cent of the EU15 average. Of the EMEs' total GDP Russia's share is 37 per cent, followed by Turkey (15 per cent), Poland (12 per cent) and Ukraine (8 per cent). The EMEs' total GDP in market prices was just 17 per cent of the EU15 total.

All the emerging market economies (EMEs) analysed in this study currently have lower GDP per capita than the EU15 countries on average (see Figure 2.1). However, Slovenia and the Czech Republic have already surpassed the poorest EU15 country, Portugal, in PPPs, and Slovenia has also caught up with Greece. The next-wealthiest EMEs are Hungary, Estonia and Slovakia followed by other Central European countries that have already joined the EU. Romania and Bulgaria are the poorest of the new EU countries.

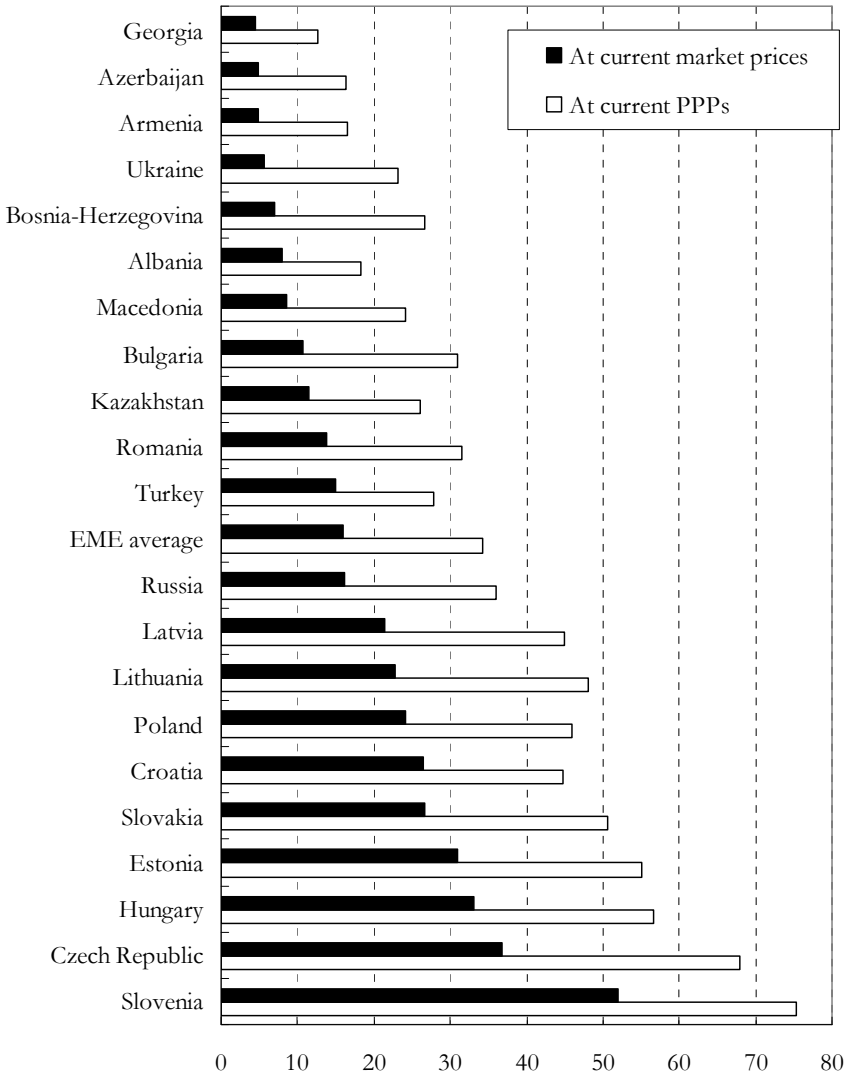
Of the EMEs that are not (yet) EU members, Croatia has the highest level of GDP per capita. It is followed by Russia and Turkey, the latter of which has about the same income level as Romania and Bulgaria. In the Balkans and in the southern republics of the former Soviet Union, GDP per capita levels are much lower than in the more advanced Central European EMEs.

In all cases, purchasing-power adjusted GDP figures are much higher than those measured in market prices. The poorer the country, the larger the relative difference is between these figures. As the countries catch up with the EU15 average, the difference between GDP in market prices and the PPP-adjusted GDP will gradually (more or less) disappear. This is because prices in the sheltered sector (services) in these countries will rise faster than prices in the open sector (manufacturing). This is a process of nominal convergence that we include in the analysis.

If we look at the GDP per capita figures in market prices, we see that average income in Slovenia is half of that in the EU15. However, Slovenia has already caught up with Portugal. The other EMEs are considerably below Slovenia. The poorest new EU country, Bulgaria has a GDP per capita in market prices which is just over 10 per cent of the EU15 average. GDP per capita in Georgia is only 5 per cent of the EU15 average.

GDP per capita in Slovenia, the wealthiest of the EMEs, is six-times higher than in Georgia in purchasing power parities, and eleven-times higher in market prices. Thus especially when measured in market prices, the EMEs remain quite poor today and are also at very different levels of income.

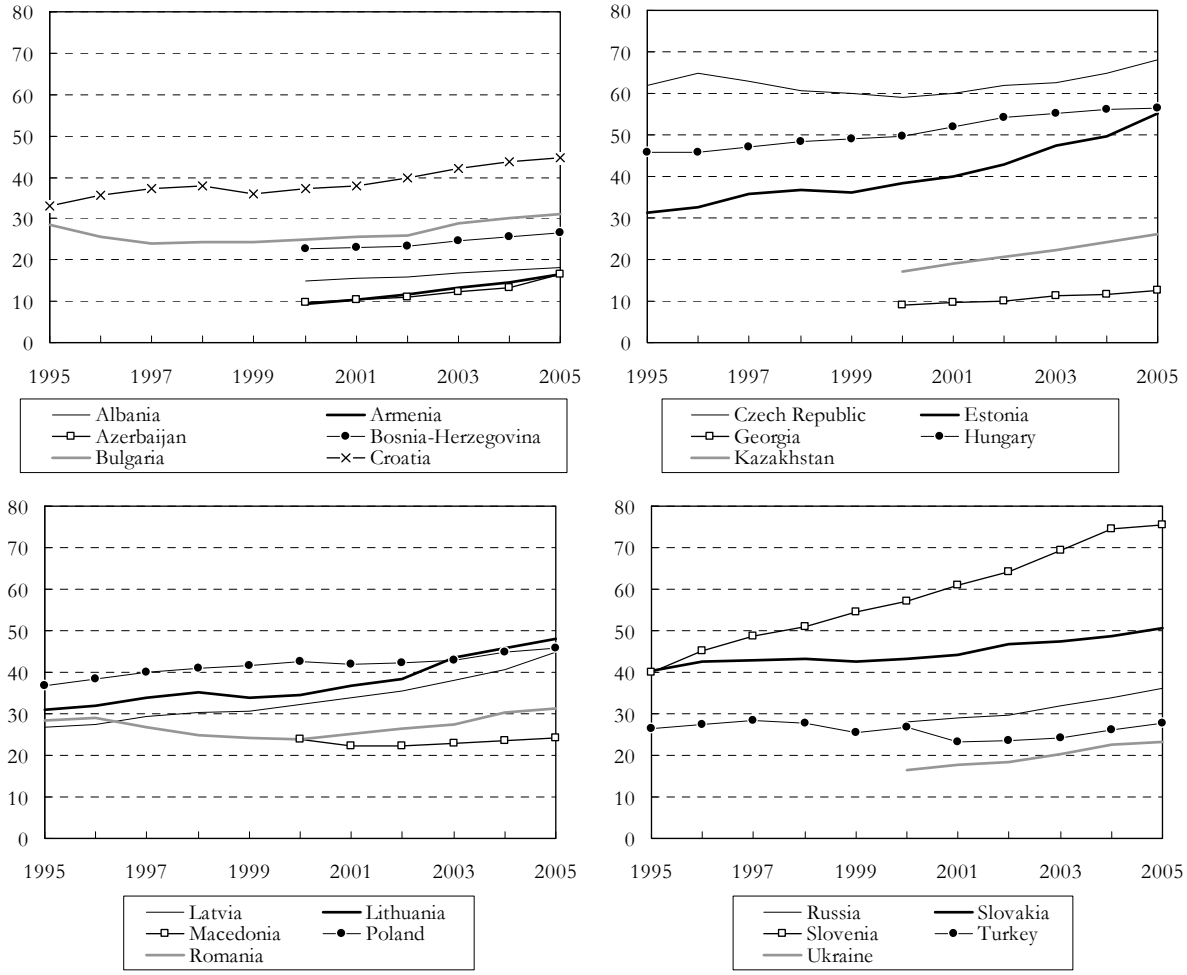
Figure 2.1 GDP per capita in the EMEs in 2005, EU15 = 100



Source: UNECE.

Figure 2.2 shows the past convergence of the EMEs towards the PPP-adjusted GDP per capita in the EU15 countries. As we see, the countries have been catching up with the EU15, but the development has varied. In some countries, such as the Czech Republic, Romania and Bulgaria there was a long period when they did not manage to catch up. Structural reforms and the EU membership process brought these countries back to faster growth.

Figure 2.2 EMEs' past convergence in purchasing-power adjusted GDP per capita in current PPPs, EU15 = 100

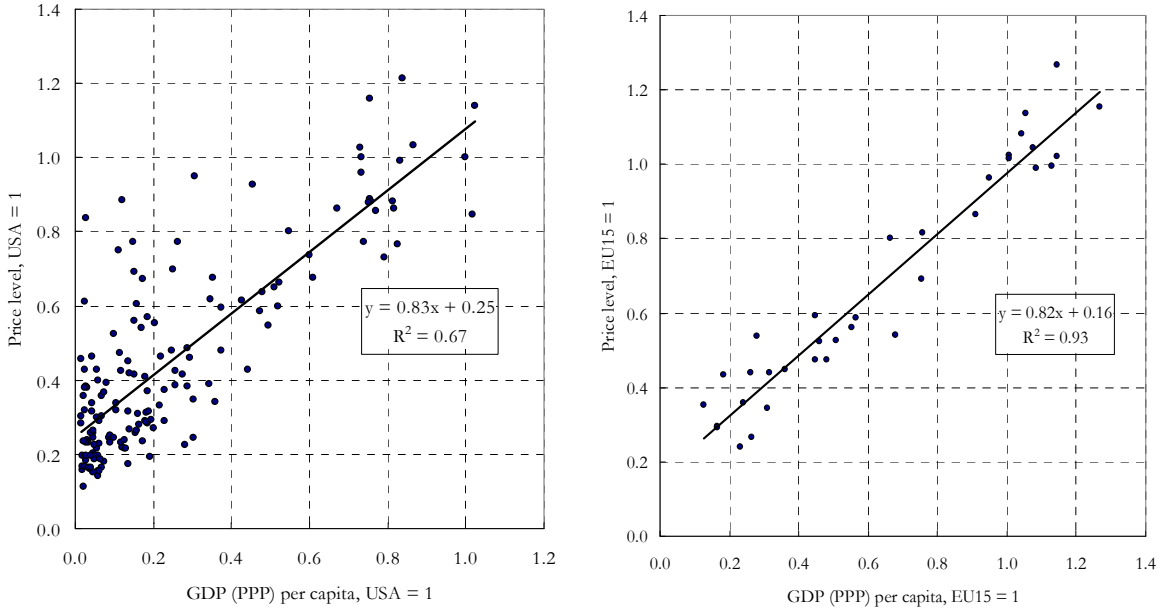


Source: UNECE.

More productive countries typically have higher incomes and higher prices. As the EMEs catch up with the EU15 we can expect also price levels to rise faster than in the EU15. For each country the relative price level is calculated as the ratio between the PPP conversion factor and the official exchange rate. The left-hand side graph in Figure 2.3 shows purchasing-power adjusted GDP per capita with respect to the United States and the relative price level for 155 countries in 2002. The R^2 is 0.67 and the coefficient between GDP per capita and the price level is 0.83.

The right-hand side graph in Figure 2.3 shows the same for the EU15 countries (less Luxembourg) and the EMEs in 2005 with respect to the EU15 average price and GDP-per-capita levels. Now R^2 is 0.93 and the coefficient between GDP per capita and the price level is by and large the same as with the larger dataset. There is thus a very strong correlation between the price level and relative GDP per capita.

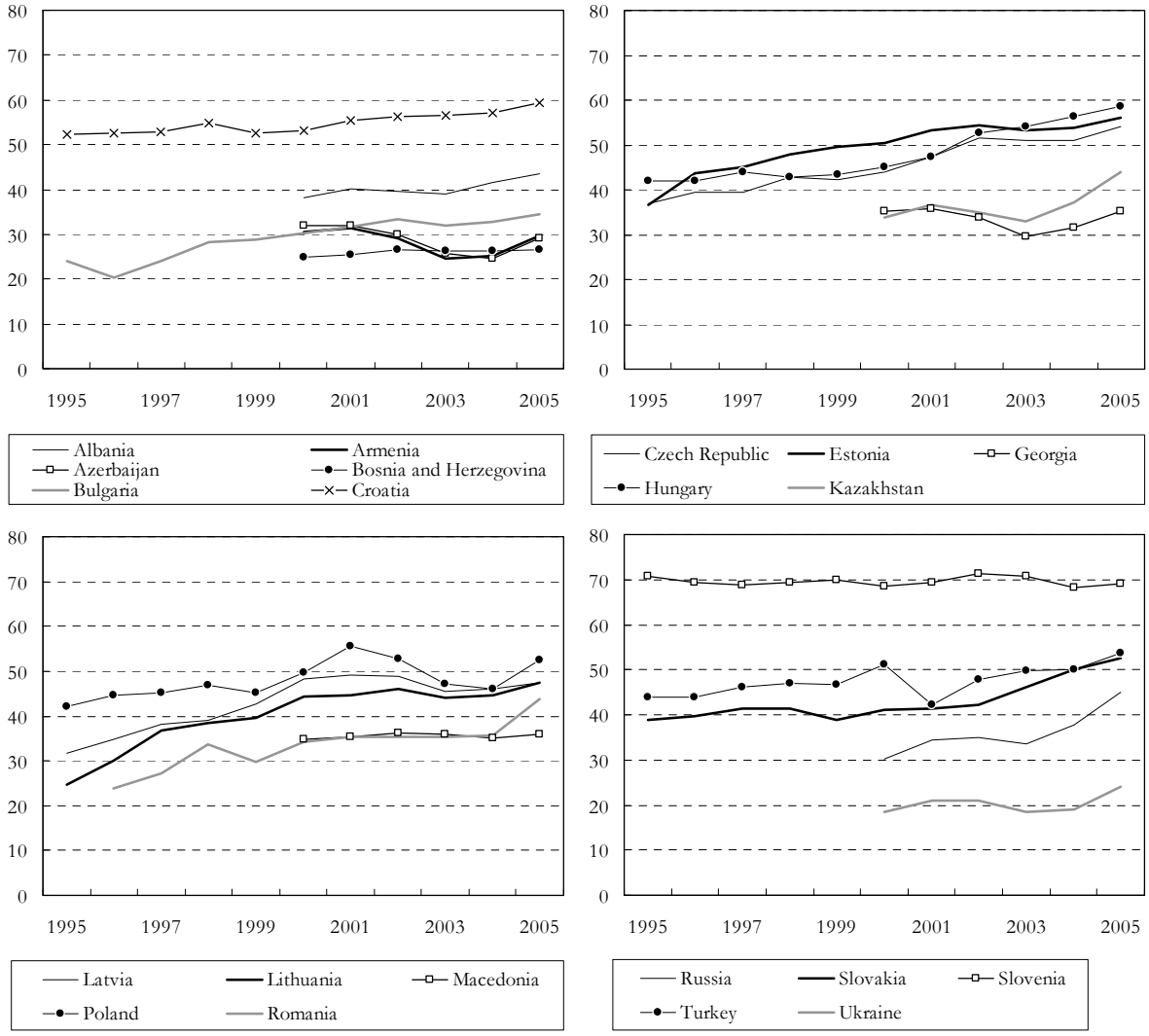
Figure 2.3 **GDP per capita and price level with respect to the United States for 155 countries in 2002 (left) and with respect to the EU15 average for the EU15 countries and the EMEs in 2005**



Sources: WDI (left) and UNECE (right).

Figure 2.4 shows how price levels in the EMEs have developed with respect to the average in the EU15 countries. In most cases price levels have been converging with the EU15 average although in some cases the development has been relatively flat. The development is influenced by, among other things, the liberalisation of administrated prices in these formerly socialist economies.

Figure 2.4 Price levels in EMEs, EU15 = 100



Source: UNECE.

3 GROWTH PROJECTIONS UP UNTIL 2050

Here we present the results from our projections. However, before reviewing the results in detail, we briefly summarise the growth framework, which is constructed in Sections 4 and 5. GDP is produced using labour and capital which are combined at some level of total factor productivity (TFP). Labour is given by the size of the working-aged population as projected

by the Eurostat for the EU countries and the US Census Bureau for the other countries. We estimate initial capital stocks using data on past GDP, investment and population.[2] The capital stocks are then projected into the future using an estimated relationship for the investment rate in the EMEs. The investment rate in the EMEs will converge towards that in the EU15 in the long term. The growth rate of TFP in the EU15 is set exogenously at 1.5 per cent, a figure we have estimated to correspond to the average historical long-run rate. Following the standard β convergence hypothesis, TFP growth in the EMEs is a function of the GDP per capita gap between each country and the EU15, and thus in the long run also the growth rate of TFP will converge with that in the EU15. In Section 7.1 we discuss separately the level of human capital in the EMEs and whether it may allow for full catching up with the EU15. We also consider nominal convergence allowing for a real appreciation of the EMEs' currencies in order to get future GDP in market prices. Nominal convergence constructed in Section 5 is a function of the real GDP per capita gap between each EME and the EU15. Finally we consider overall uncertainty related to these projections, and the rates of return on capital.

3.1 Projections for total GDP

With our assumptions and specifications, the EU15 countries' GDP will grow at an average rate of 1.9 per cent in 2006-2050. This includes an average TFP growth rate of 1.5 per cent and an average investment rate of 18.5 per cent. The capital stock will remain broadly constant relative to GDP by a factor of 3.2.

By contrast, average PPP-adjusted GDP in the EMEs is projected to grow at a rate of 3.7 per cent in 2006-2050 with an average TFP growth rate of 2.6 per cent and an average investment rate of 20.7 per cent. The capital stock will rise from an estimated current level of 2.3 times the GDP to a projected 3.1 times the GDP in 2050. PPP-adjusted GDP will rise from 37 per cent of the EU15 GDP in 2006 to 81 per cent in 2050, while GDP in market prices will rise from 17 per cent to 69 per cent of the EU15 GDP. Total PPP-adjusted GDP in the EMEs is projected to increase by a factor of 4.9 and by a factor of 9.0 in market prices.

The EMEs total population is currently 5 per cent larger than that in the EU15. Population projections by the Eurostat and US Census Bureau show that in 2050 the EMEs' total population is expected to be 6 per cent smaller than that of the EU15. This 11-percentage point decrease relative to the EU15 will of course have an effect on the relative size of the GDPs. See Figure 4.3 on how working-aged population aged 15-64 years is projected to change in the EU15 and the EMEs. The changes are considerable and very different depending on the country.

Figure 3.1 shows GDP in the EU15 and the EMEs as a whole both in purchasing-power adjusted terms and market prices in billions of 2005 US dollars in 1995-2050 on the basis of our projections. The EMEs as a group are expected to reach the current EU15 PPP-adjusted GDP in 2027 and the GDP in market prices in 2035.

Figure 3.2 shows projected GDP in the six largest EMEs in purchasing-power adjusted terms in constant 2005 US dollars. These countries account for 80 per cent of the total GDP of the 21 EMEs. Russia and Turkey leave the other four countries behind. Russia does not really grow faster but as a larger country GDP becomes larger in absolute terms, if not in relative terms. Turkey's GDP grows faster because of its strong population growth. Russia's

[2] Investment or gross fixed capital formation refers to investment as determined in national accounts, that is, including investment into buildings, infrastructure, machinery, equipment etc. It does not matter whether the investment is done by a local or a foreign firm. Also public sector investments are included. Foreign direct investment is only included in the form of greenfield investments. Portfolio investments are not included.

average projected GDP growth rate in 2006-2050 is 3.3 per cent while that of Turkey is 4.8 per cent.

Figure 3.1 Projected GDP in the EU15 and the EMEs as a whole in purchasing-power adjusted terms and in market prices, bill. 2005 USD

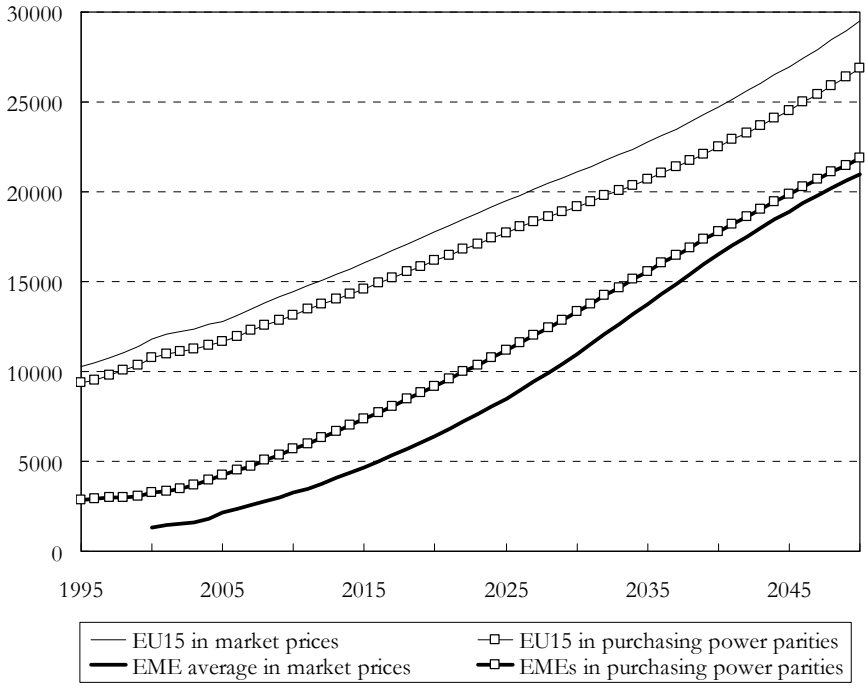


Figure 3.2 Projected GDP in the largest EMEs in purchasing-power adjusted terms and in market prices, bill. 2005 USD

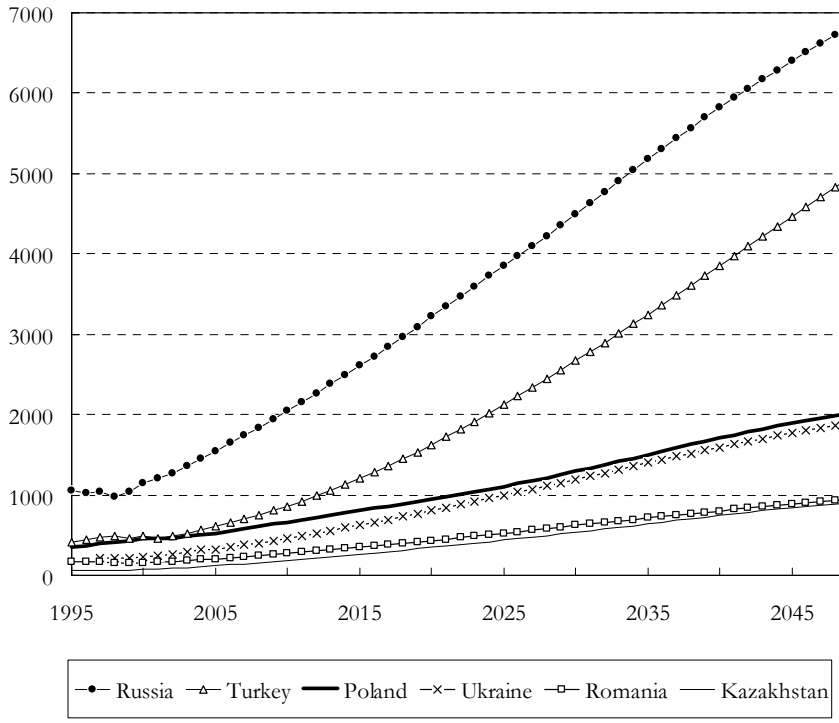


Figure 3.3 shows the current and projected total GDP in the combined EU15 and EME region. We have shown separately the four largest EMEs. The share of the EU15 is projected to decline from 73 per cent to 56 per cent and the EMEs' share to increase accordingly. The share of Russia is projected to increase from a current 10 per cent to 14 per cent, and that of Turkey from 4 per cent to 10 per cent. Also the shares of Poland and Ukraine will increase.

Figure 3.3 Total PPP-adjusted GDP in the EU15 + EME region, bill. of USD and % of total

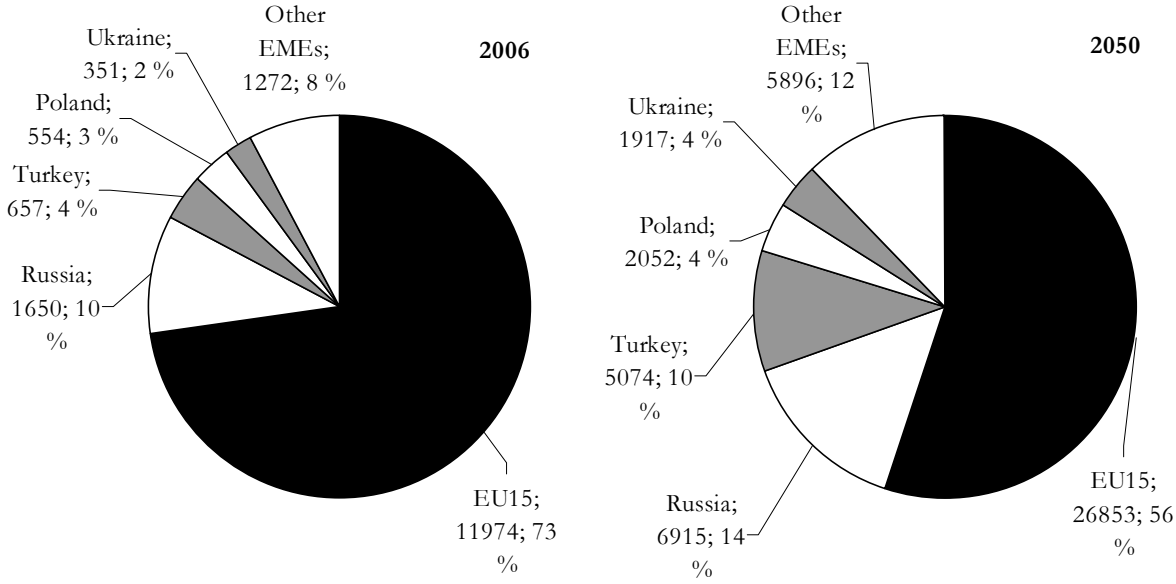
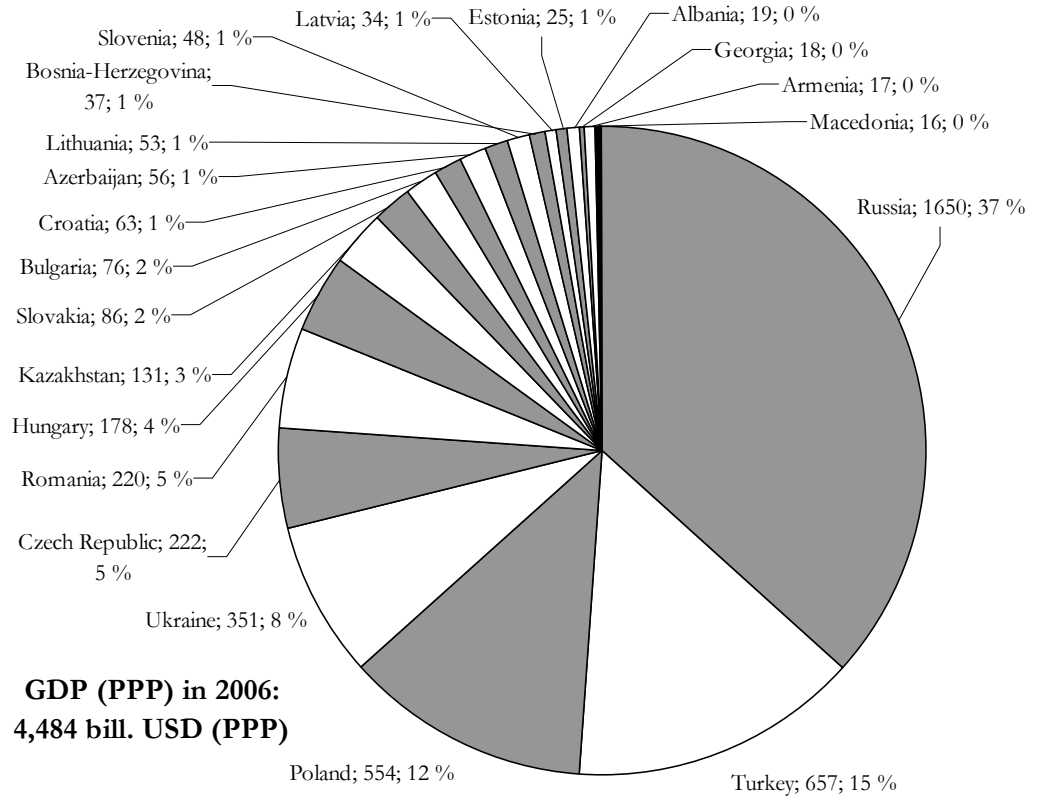


Figure 3.4 shows purchasing-power adjusted GDP in each EME in 2006 and 2050 in billions of 2005 US dollars and also the countries' share in the total GDP of the EMEs. As relative population changes are rather large and because differences in income levels in 2050 are projected to be smaller than they are currently, there will be changes in the EMEs' order as well as in their shares of the EMEs' total GDP.

For example, Russia's GDP is projected to grow from 1,650 billion US dollars to 6,915 billion, but, largely due to demographic changes, its share in the EMEs' total GDP is projected to decrease from 37 per cent to 32 per cent. On the other hand, Turkey, with strong population growth, is projected to increase its GDP from 657 billion US dollars to 5,074 or from 15 per cent to 23 per cent of the total. Towards the lower end, Macedonia, Armenia, Georgia and Albania are projected to surpass Estonia, because of both demographic factors and because these four countries currently have much lower GDP per capita than Estonia does which means that they also have much more room for income convergence and thus growth. Estonia has by far the smallest population of the EMEs.

Figure 3.5 shows the population projections by the Eurostat and the US Census Bureau. The relative changes between the EMEs are large. Russia's population is projected to decline from 142 million to 109 million, while that of Turkey will rise from 70 million to 86 million. The population of Ukraine is projected to fall by 13 million to 34 million and that of Poland by 4 million also to 34 million. In relative terms, the largest declines are expected in Bulgaria (-34 per cent), Ukraine (-28 per cent), Russia (-23 per cent) and Romania (-21 per cent).

Figure 3.4 Purchasing-power adjusted GDP in the EMEs in 2006 and 2050 in billions of 2005 US dollars and per cent of total GDP in the EMEs



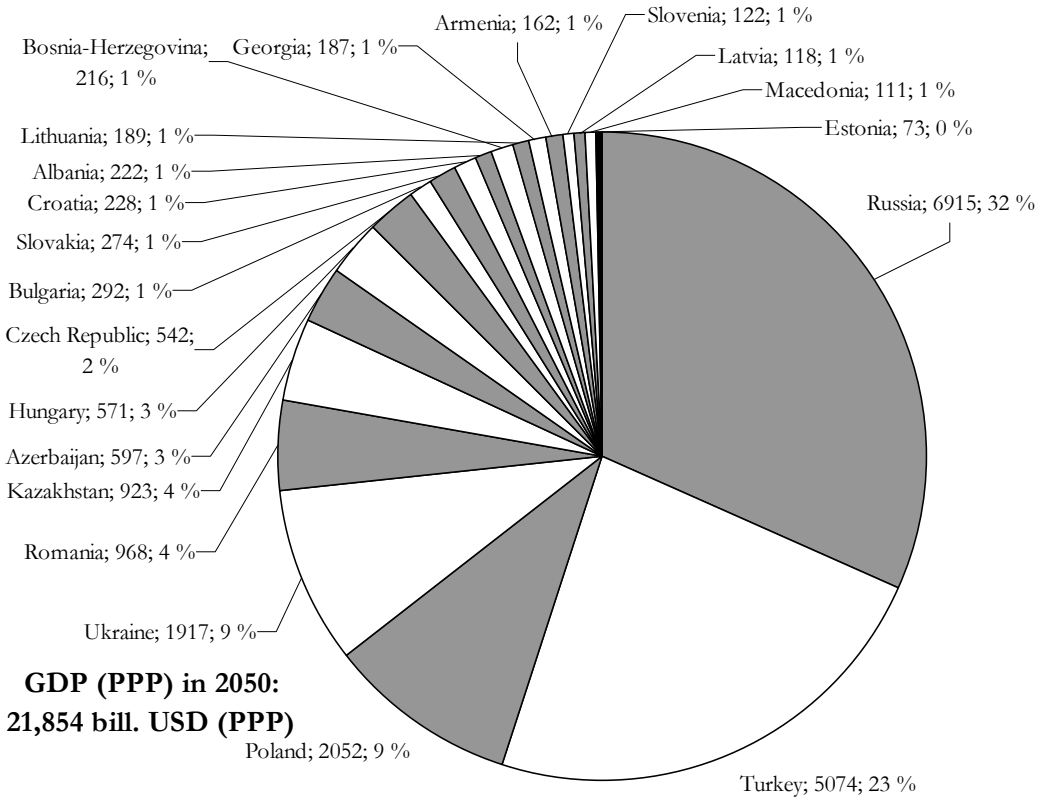
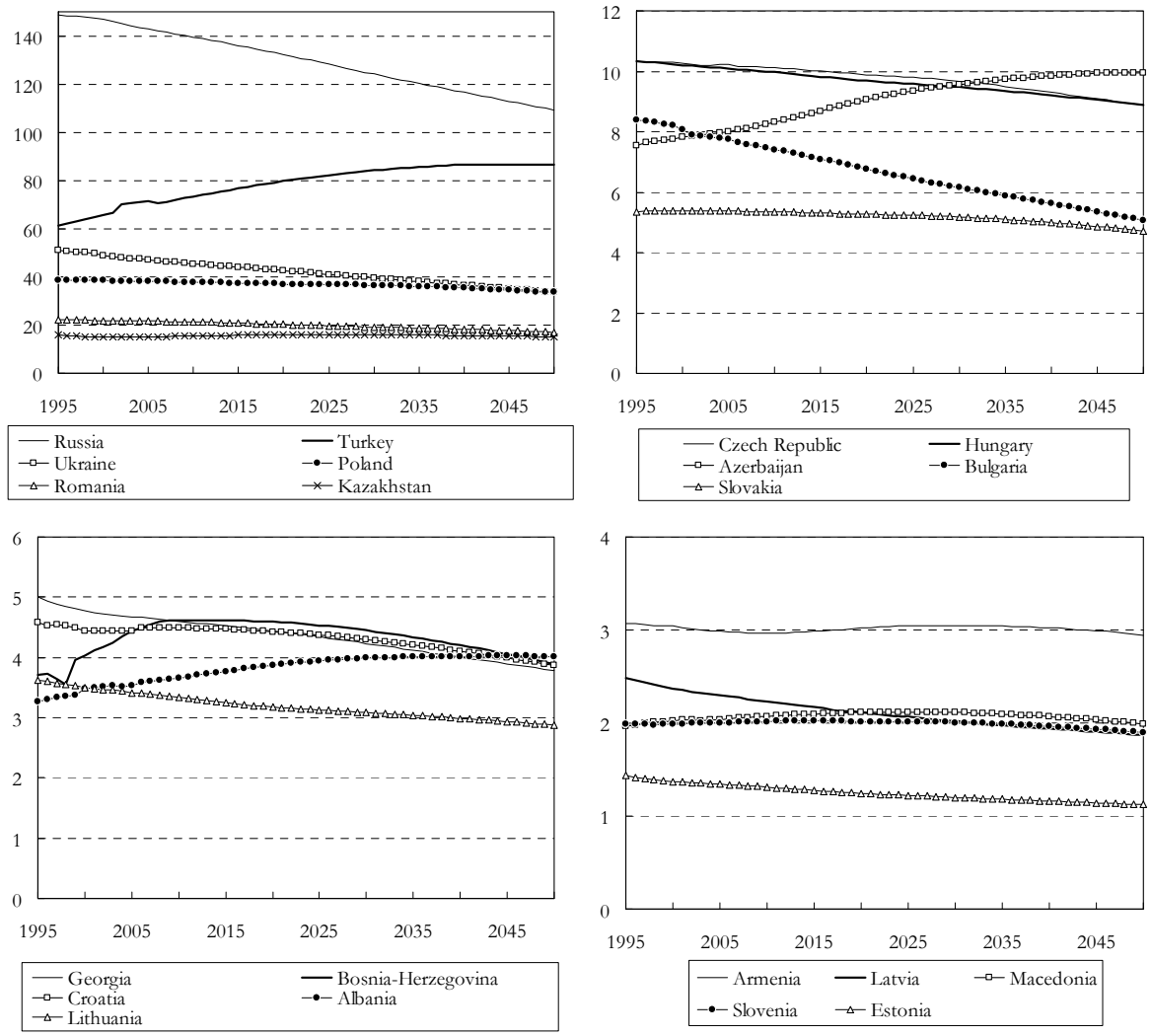


Figure 3.5 Population projections, mill.



Sources: Eurostat and the US Census Bureau.

3.2 Projections for GDP per capita

On average, real GDP per capita is projected to grow at a rate of 1.9 per cent in the EU15 countries and at a rate of 3.9 per cent in the EMEs in 2006-2050. PPP-adjusted GDP per capita will rise from an average of 36 per cent of the EU15 level in 2006 to 87 per cent in 2050, while in market prices it will rise from 16 per cent to 73 per cent. In constant prices, the EMEs' are projected to reach the current PPP-adjusted GDP of the EU15 countries in 2027. Thus we do not expect the EMEs' on average to have fully converged with the EU15 by 2050. Some of the countries are likely to have, however, even though the model does not show this.

Table 3.1 shows the projected level of PPP-adjusted GDP per capita in the EMEs relative to the EU15. The countries are sorted by their projected income level in 2050. According to this projection, the top-6 countries will be the three Baltic countries, Hungary Slovenia and Russia which would exceed 90 per cent of the EU15 income level. Four countries: Bosnia-Herzegovina, Albania, Armenia and Georgia are projected not yet to have reached 80 per cent of the EU15 level. These four are currently among the poorest of the EMEs. The differences between the countries in 2050 are much smaller than they are presently. This is a result

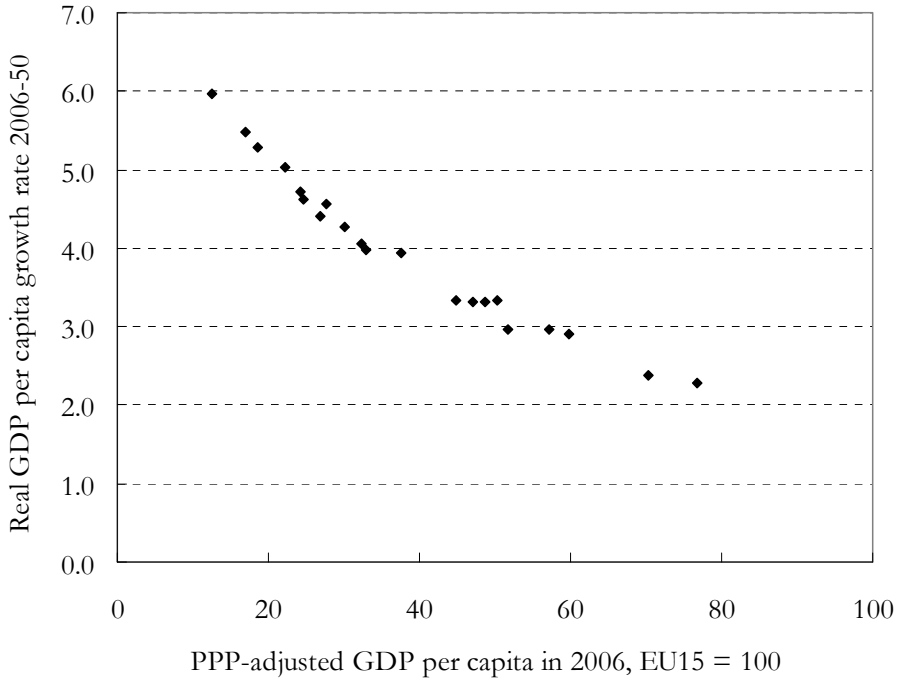
of the β convergence characteristic of the model, namely that poorer countries will tend to grow faster than wealthier ones.

Table 3.1 Projected PPP-adjusted GDP per capita in the EMEs, EU15 = 100

Country	2000	2010	2020	2030	2040	2050
Lithuania	34	58	74	84	92	94
Estonia	38	68	79	87	94	93
Hungary	47	62	72	82	90	92
Slovenia	67	80	85	88	92	92
Russia	27	44	60	76	88	91
Latvia	31	57	71	82	90	91
Czech Republic	59	73	77	83	88	87
Kazakhstan	17	36	53	69	83	87
Poland	41	52	63	74	85	87
EME average	28	42	57	71	83	87
Azerbaijan	10	31	50	67	80	86
Croatia	37	51	62	71	80	84
Turkey	26	35	50	66	78	84
Slovakia	42	57	66	74	81	83
Bulgaria	24	39	55	69	79	82
Ukraine	16	30	46	63	77	82
Romania	25	38	53	67	77	81
Macedonia	24	29	42	58	72	80
Bosnia-Herzegovina	23	32	48	61	73	79
Albania	13	22	36	52	69	79
Armenia	10	26	44	60	74	79
Georgia	8	17	30	45	61	71

This characteristic can also be seen in Figure 3.6 which shows how the projected GDP per capita growth rates relate to the initial PPP-adjusted levels in 2006. We see that there is a clear connection between these, which is based on the β hypothesis and the common β. The relationship between the growth rate and the initial income level is very clear in the model. Can this be justified based on historical evidence?

Figure 3.6 **Initial GDP per capita levels and its projected future growth rates in the EMEs, %**

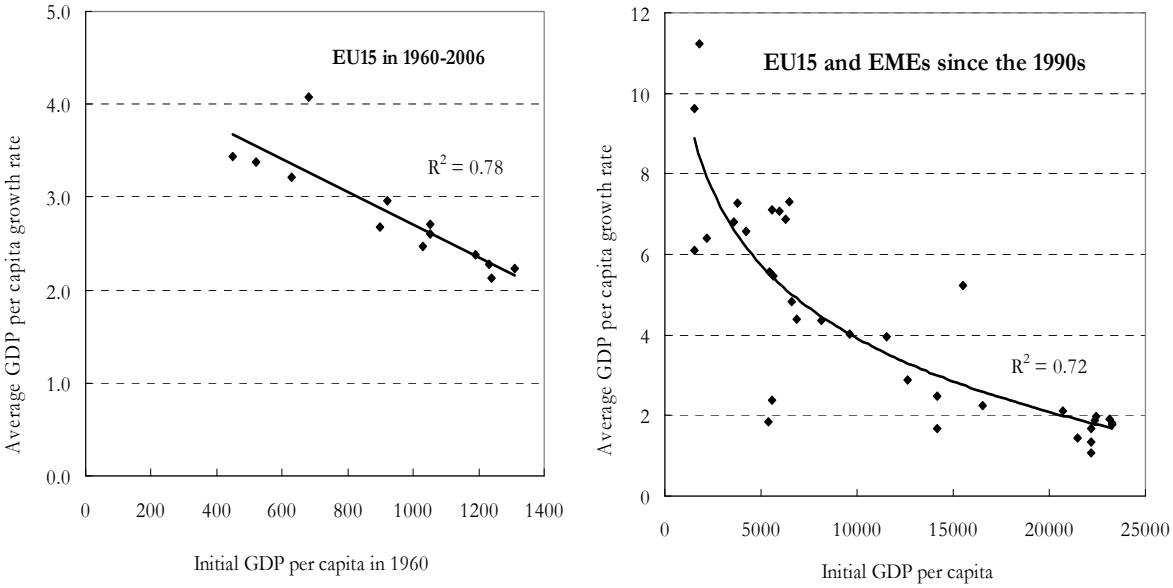


In the left-hand side graph of Figure 3.7 we show the relationship between PPP-adjusted GDP per capita in the EU15 countries (less Luxembourg) in 1960 and the subsequent growth rate up until the present. As we see, there is clear evidence of unconditional convergence in the EU15 area. The R^2 value is high at 0.78 which would rise to 0.95 if we were to remove Ireland which is somewhat an outlier.

In the right-hand side graph we find on the horizontal axis PPP-adjusted GDP per capita in the EU15 countries (less Luxembourg) in 1990 and in the EMEs in their respective income troughs between 1991 and 1999. On the vertical axis we find the subsequent average annual growth rates up until the present. As growth in the EMEs resumed at different points in time after an initial decline in their output following the move towards becoming market economies, we have to choose the initial year differently for each country. Again the R^2 value is relatively high at 0.72. It would rise to 0.82 if we were to remove Macedonia and Turkey that have grown at an average rate of just 2 per cent annually despite a low initial income level, and further to 0.84 if we were to remove Ireland, too.

Based on this historical evidence, we argue that at least in so far as the EMEs reform their economic structures and allow for working markets and economic integration with the rest of the world, convergence is likely to continue. Those EMEs that are or will become EU members are better sheltered against national policies that could interrupt this development.

Figure 3.7 **PPP-adjusted GDP per capita in the EU15 countries in 1960 and its average growth rate in 1960-2006 (left-hand side graph) and PPP-adjusted GDP per capita in the EU15 countries in 1990 and the EMEs in their troughs in the 1990s and average annual growth rates up until 2006 (right-hand side graph)**



Note: Excluding Luxembourg.
Source: Eurostat.

Figure 3.8 shows all the 21 EMEs and their projected real and nominal convergence towards the EU15 GDP per capita level. The pace of catching up slows down towards the end of the period. This is because the force of the factors that produce the convergence in the model decreases as the income gap decreases. Some of the countries seem to run out of steam before full convergence is reached. In the model this can arise from a less favourable development of the labour force (see Sections 6.3 and 7.1 for more discussion of this). As Figure 4.3 shows, the projections for working-aged population start to deteriorate in the EMEs on average relative to the EU15 in the mid-2030s. In the 2040s, the size of the working-aged population is projected to decrease more than in the EU15 in all EMEs save Azerbaijan and Albania.

Figure 3.8 Real and nominal GDP per capita convergence, EU15 = 100

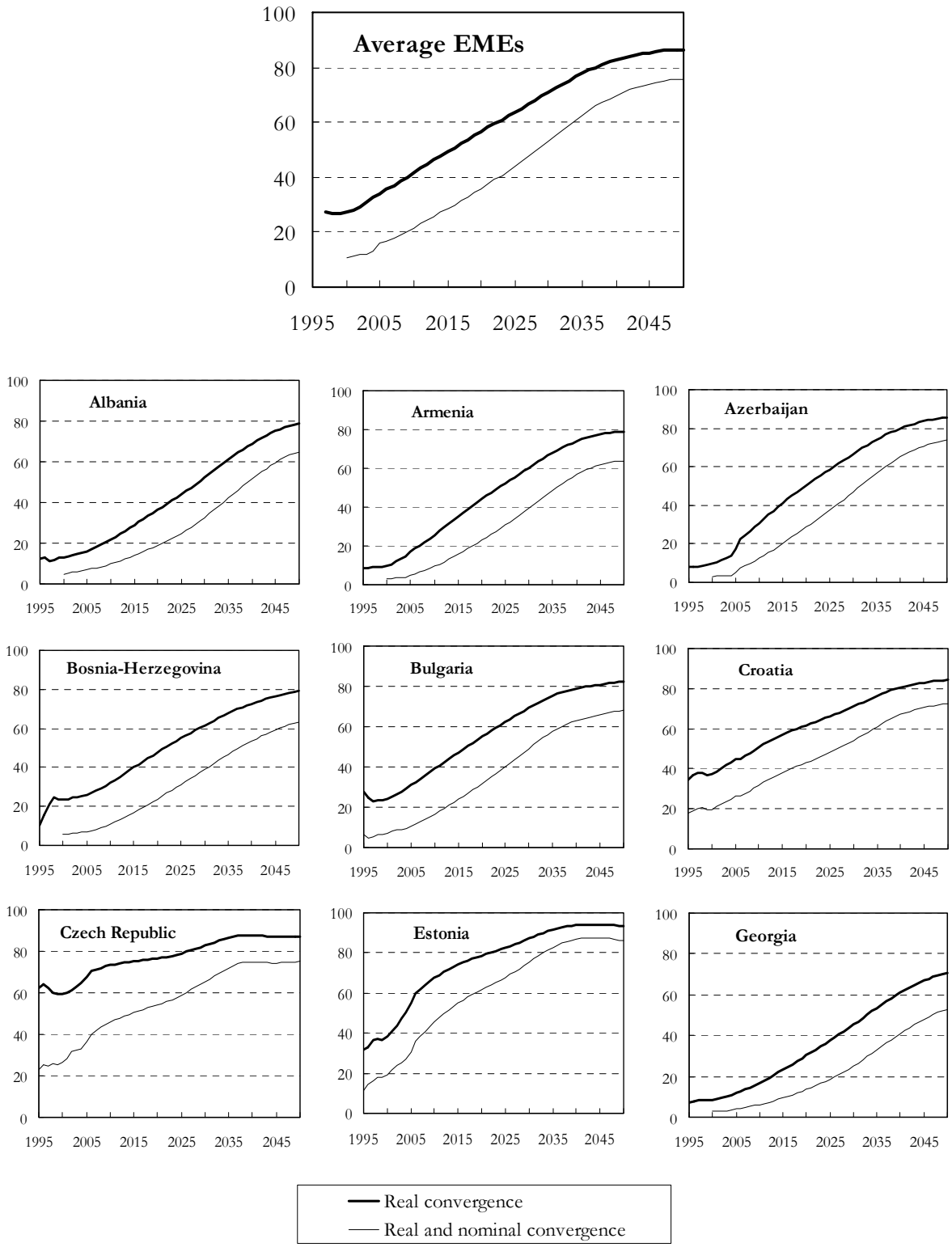
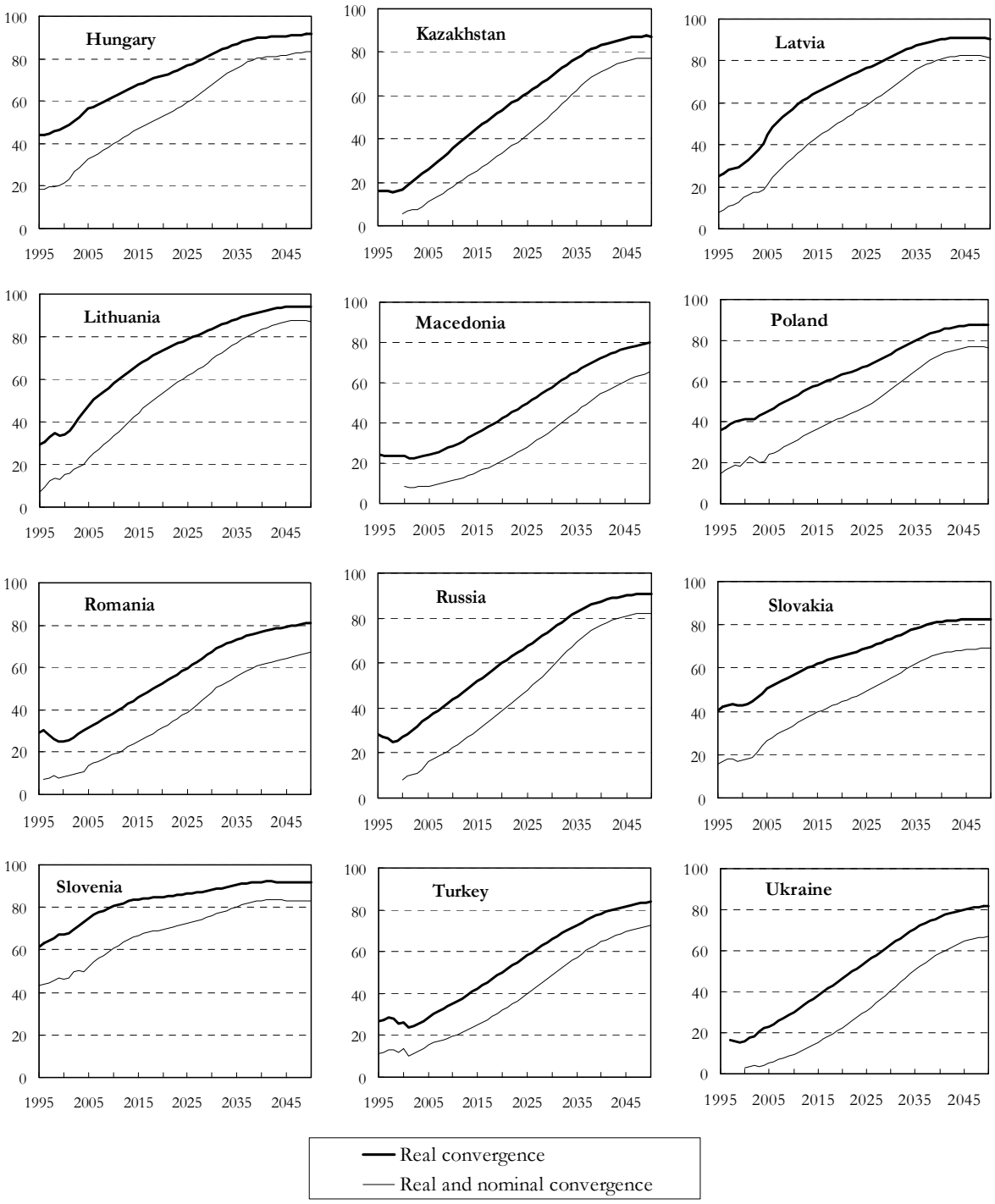


Figure 3.8 Real and nominal GDP per capita convergence, EU15 = 100 (Cont'd)



4 MODEL OF REAL GDP GROWTH AND CONVERGENCE

We now turn to construct the framework used in the growth projections. In order to make projections of the trend growth of real GDP several decades into the future we need a framework based on growth theory. We also have to make a number of assumptions. The countries that we analyse are compared with the average development in the EU15 countries. Thus we need to project future growth for both the EU15 and the EMEs. Some of the variables for the EMEs are functions of the projected development in the EU15 countries.

We need to estimate the current capital stock, future investment rates, and the growth rate of total factor productivity. The other factor of production besides physical capital is labour that we take as given from international databases. We use historical data for 1995-2006 to pinpoint the countries' starting positions and then extrapolate from there using certain assumptions. Historical purchasing-power adjusted GDP and gross fixed capital formation are taken from the UNECE database. In a few cases we have taken the investment rate from the WDI database by the World Bank, because of gaps in our principal data source.

4.1 The production function

In the tradition of neo-classical growth theory, production (GDP) is determined by a constant-returns-to-scale Cobb-Douglas production function given by

$$Y = AK^{\alpha}L^{1-\alpha}, \tag{1}$$

where Y is gross domestic product, A is total factor productivity (TFP), K is the capital stock, L is labour given by the 15-64 year old population and α is the elasticity of output with respect to capital (and also, assuming perfect competition, the share of capital in total income). We set α uniformly at 0.33 for all the countries as is often done in empirical work.[3]

4.2 Growth in total factor productivity

The change in total factor productivity is that part of the change in real GDP that cannot be explained by changes in the capital stock and labour. For example if GDP increases by 1 per cent, but both the capital stock and labour are unchanged, then TFP has risen by 1 per cent. This means that the existing factors of production K and L have been used more efficiently than before. In fact, long-term (steady-state) income growth comes from increasing total factor productivity.

For the EU15 countries the average future growth rate of TFP is set exogenously at 1.5 per cent annually. This is consistent with an average labour productivity growth of slightly above 2 per cent.[4] According to estimations that we have made using the framework constructed in this analysis, the average growth rate of TFP in the EU15 countries in the 1960-2006 period

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[3] For example, Barro et al. (2001) use 0.30, while Mankiw et al. (1992), Wilson and Purushothaman (2003), Benhabib and Spiegel (2005) and Poncet (2006) use 0.33.

[4] Labour productivity can be written on the basis of (1) as $Y/L = A(K/L)^{\alpha}$, and the optimal condition for capital accumulation can be written on the basis of the marginal productivity of capital as $K/L = \left((\rho+\delta)/\alpha A\right)^{1/(\alpha-1)}$, where ρ is the cost of capital. Inserting this into the first expression we get $Y/L = A^{1/(1-\alpha)}\left((\rho+\delta)/\alpha\right)^{\alpha/(\alpha-1)}$. As over time the cost of capital has remained roughly constant, we can assume that the growth rate of labour productivity is approximately equal to $1/(1-\alpha)$ times the growth rate of TFP. With α = 0.33 and TFP growth in the EU15 equal to 0.015 we get a labour productivity growth rate of 2.2 per cent.

was 1.6 per cent. Thus the assumed future TFP growth rate is very close to its historical average. Of course, in reality there are periods of higher and lower TFP growth over the course of time. These are related to, among other things, the stage of the business cycle and technological advances. A study such as this one does not aim to take into account business cycles.

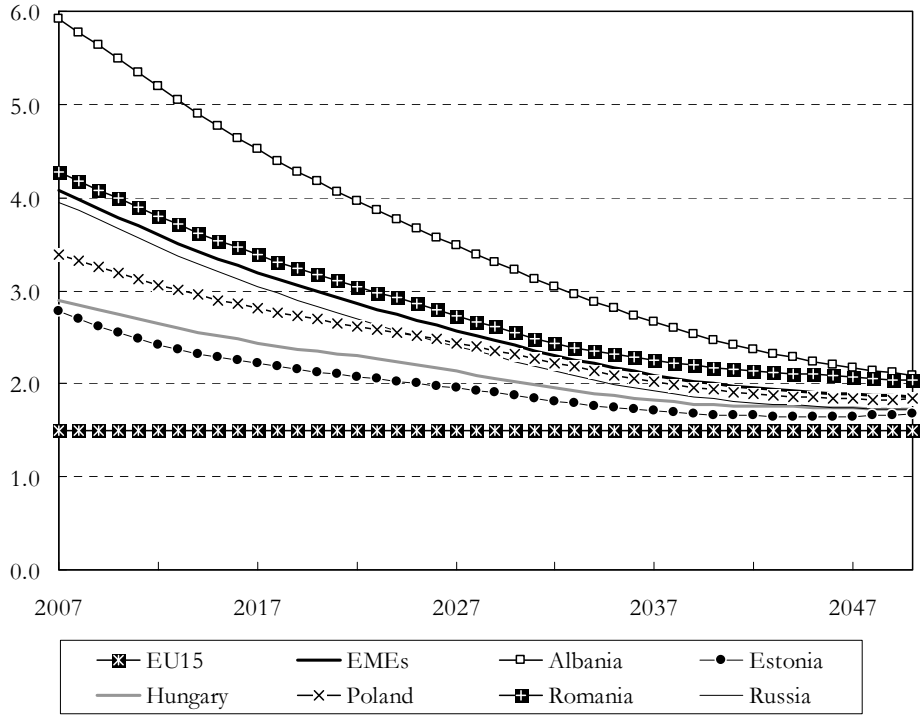
TFP growth in the EMEs can be expected to be higher than in the more advanced EU15 countries that are closer to the technological frontier. This is because the EMEs can imitate and adopt modern production technology and copy best practices from more advanced countries and thus grow faster. The EMEs have in many cases also benefited from flows of foreign direct investment from more advanced economies. Unlike the EMEs, the advanced countries need to be more innovative in expanding their output as they are on or close to the technological frontier.

As a simple measurement of the speed of catching up we use the β convergence specification, a standard element in growth literature. Let $a = \log A$. Then $\hat{a}_t = a_t - a_{t-1}$ is the growth rate of TFP, which is given in the EMEs by

$$\hat{a}_{EME,t} = \hat{a}_{EU15,t} - \beta \log\left(\frac{y_{EME,t-1}}{y_{EU15,t-1}}\right), \tag{2}$$

where $\hat{a}_{EU15} = 0.015$ is the exogenously set TFP growth rate in the EU15, β is the speed of convergence, and y is per capita GDP. As the income gap decreases, the second term on the right-hand side goes to zero and the growth rate of TFP in the EMEs converges to that in the EU15 countries. Then also the levels of TFP will be broadly similar. Figure 4.1 shows projected TFP growth rates for selected EMEs and the EU15.

Figure 4.1 Projected trend TFP growth rates in selected EMEs and the EU15, %



The choice of β is quite critical for the speed of convergence (see Section 6.3 for the effect of a different choice of β). For example, Barro et al. (2001) use 0.014 for β in their closed-

economy framework and 0.023 in their open-economy framework that allows for international borrowing and lending, while Wilson and Purushothaman (2003) use 0.015. Kaitila (2004) finds that the conditional convergence rate has varied between 0.016 and 0.034 for the EU15 countries depending on the model specification. Dobson et al. (2006) review the estimation results from 38 studies on international convergence. Taking the simple average of the results quoted there gives us an estimated β of 0.016 with a standard deviation of 0.012 and a range between -0.007 and 0.057. The estimation results thus vary a lot. The results are influenced by, among other things, sample design and methodology. If we pick just the studies made on more advanced countries we get a simple average of 0.019 with a standard deviation of 0.008. On the basis of these we set the convergence coefficient β at 0.025, which is a little on the high side but still within the range of empirical growth estimations.

In line with the tradition of neo-classical growth theory, we have assumed that β is fixed. In reality, the speed of convergence is not the same for all countries. Poncet (2006) links the growth rate of TFP to the level of human capital. Then it does not suffice for a country to be poor to grow faster, but also needs to have a reasonable level of human capital in order to catch up with the leading economies. We discuss the EMEs' levels of education from this point of view in Section 7.1.

4.3 Investment and capital stocks

In order to calculate GDP projections we need to know the countries' capital stocks. Estimates for capital stocks are typically not available in international databases. Eurostat does publish net capital stock figures for the EU15 countries so we can calibrate our EU15 calculations against those and see how our setup on estimating the initial capital stocks works.

Following Benhabib and Spiegel (2005), we calculate the initial net capital stock using the following steady-state formulation:

$$K_0 = \frac{Y_0 \bar{i}}{g + \delta + n}, \tag{3}$$

where Y_0 is real GDP in the initial year, $\bar{i}$ is the average annual investment rate (investment-to-GDP ratio) during the time period between the initial year and 2006, g is the average GDP per capita growth rate during the same time period, δ is the depreciation rate and n is the average population growth rate. This formulation comes from steady-state growth equilibrium where the flow of investment is equal to the full depreciation rate $(g + \delta + n)$ times the capital stock. The starting year in our estimations for the EMEs is 1997. This formulation may in principle overestimate the capital stock in the EMEs that are in the process of transition from socialist to market economies, but after 15 years of transition this bias is likely to be quite small.

After having calculated initial capital stocks, we extrapolate them to the present by using the standard perpetual inventory method (PIM):

$$K_t = K_{t-1}(1-\delta) + I_t, \tag{4}$$

where I_t is gross fixed capital formation in constant prices in time period t.

The depreciation rate δ is set uniformly at 0.04. This is not only a standard assumption[5] in empirical growth literature but we have also derived it for the EU15 area by finding the de-

[5] Barro et al. (2001) and Poncet (2006) use δ = 0.05, while Wilson and Purushothaman (2003) use 0.04 and Benhabib and Spiegel (2005) use 0.03. Mankiw et al. (1992) use 0.05 for the sum of the depreciation rate and the exogenous rate of TFP growth.

preciation rate that gives us the best fit for 1960-2006 between the capital stock time series calculated by the Eurostat and our estimate calculated on the basis of (3) and (4).

Using equations (3) and (4) we get an estimate of the net capital stock in 2006 in constant 2005 prices. For 2006 onwards we use a model for the investment rate for each country in order to estimate future net capital stocks that are needed to calculate future GDP. Following Barro et al. (2001) we use a steady-state investment rate for the EU15 countries derived from a model of optimal growth and given by

$$i_{EU15,t} = \frac{\alpha\left(\delta + \frac{1}{5}\sum_{i=t}^{t+4}\lambda_i + \hat{a}\right)}{\delta + \rho}, \tag{5}$$

where i is the investment rate, $\frac{1}{5}\sum_{i=t}^{t+4}\lambda_i$ is the average growth rate of the working-aged population in the next five-year period, $\hat{a}$ is the average TFP growth rate (0.015), and ρ is the steady-state real interest rate set at 0.051 to represent a long-term average of real rates of return in the stock market.[6] This will give us an average investment rate of 18.5 per cent in the 2006-2050 period. This is below the 19.8 per cent average in the EU15 area in 1995-2006, but weaker future population developments are likely to lead to lower investment rates.

Wilson and Purushothaman (2003) assume a fixed investment rate for catching-up countries. This is not realistic, however. As the countries catch up with more advanced economies, the growth rate of total factor productivity will slow down, the rates of return on investment will converge with those in the more advanced economies, and thus also the investment rate should converge, that is, generally speaking decline. For example, if we were to assume that a country would continue to have an investment rate of 25 per cent even after having converged with the EU15 area that has an investment rate of 18.5 per cent, the former would likely be engaged in overinvestment with very low rates of return. This would not be sustainable in the long run.

Consequently, we assume that the investment rate in the EMEs will converge to that in the EU15 countries. For this we have used the following equation:

$$i_{EME,t} = i_{EU15,t} + \eta\left(i_{EME,t-1} - i_{EU15,t-1}\right) + \varphi\left(\gamma_{EME,t} - \gamma_{EU15,t}\right), \tag{6}$$

where γ is real GDP growth rate. The first term on the right-hand-side is the investment rate in the EU15 region as calculated from (5). As GDP growth rates converge, the third term on the right-hand side goes to zero, and this will also bring the second term down to zero. We have estimated the two constants, η and φ, from large historical datasets using pooled least squares. The estimation results are presented in Table 4.1. On the basis of these results we have set η = 0.88 and φ = 0.20. A constant was not statistically significant and is therefore not included in the specifications. This setup means that in the long run there are no differences in savings rates between the EMEs and the EU15. It does allow for the currently diverging savings rates, however. Figure 4.2 shows historical and projected investment rates in selected EMEs and EU15.[7]

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[6] We have chosen ρ so as to keep the capital-stock-to-GDP ratio stable into the future as it has been during 1960-2006. Barro et al. (2001) use a ρ value of 0.06. They also include taxation and human capital in their model. We abstract from these.

[7] As for other investment-rate approaches in recent studies, Poncet (2006) uses a quadratic formulation, where the savings rate and thus the investment rate is a function of the previous period's savings rate, GDP per capita ratio between the country and the USA, the square of that ratio, and the GDP growth rate. Her projections have the

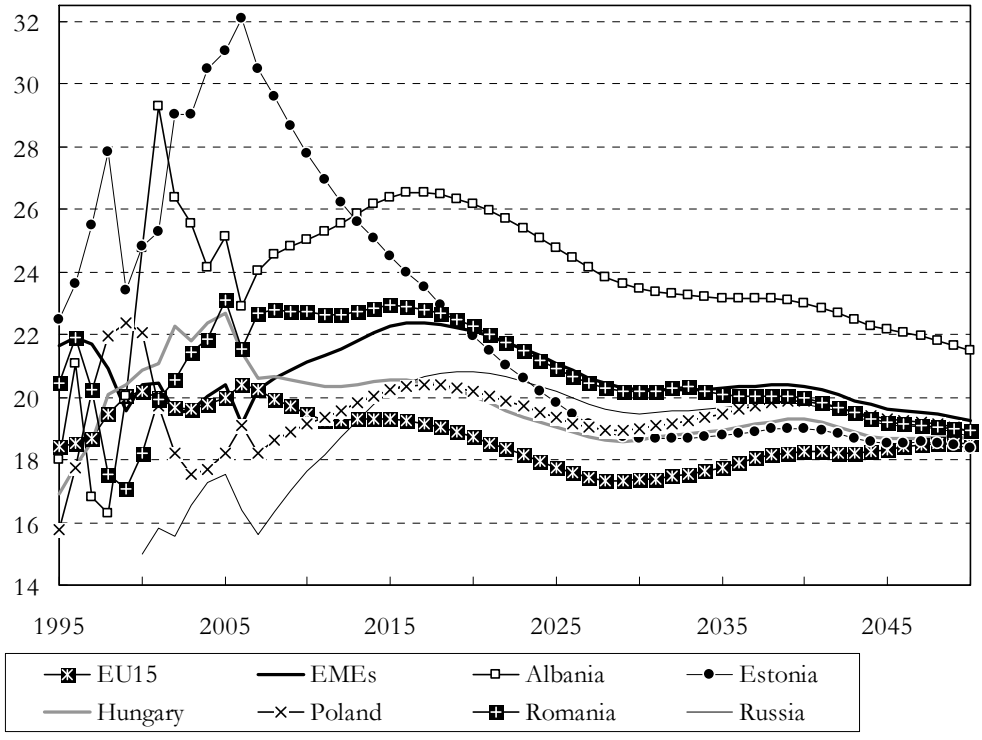
In our projections, capital-stock-to-GDP ratios (K/Y) in the EMEs will tend to rise into the future. In fact, K/Y ratios will more or less converge with that in the EU15 area. Given the large investment needs of all the EMEs and their low starting levels, a rising K/Y is logical.

Table 4.1 Estimation results for the investment equation

	Long-term global estimation	Long-term global estimation without LDCs*	EU15 and EMEs
Time period	1975-2002	1975-2002	1990-2005
Number of countries	159	103	35
Total number of observations	3 283	2 021	366
η	0.878***	0.897***	0.941***
	(0.008)	(0.009)	(0.021)
φ	0.093***	0.141***	0.209***
	(0.011)	(0.015)	(0.030)
Adjusted R^2	0.799	0.828	0.858
Durbin-Watson	1.927	1.814	1.387

Notes: Early years of transition removed for EMEs. LDCs = least developed countries. *** = significant at 1 per cent. Standard errors are shown in parentheses.

Figure 4.2 Historical and projected investment rates in selected EMEs and EU15, %



same kind of inertia as ours in that poor countries that currently have a low investment rate will continue to have them in the future.

4.4 Labour

Given our growth framework, population development is the principal factor that separates the countries from one another. The EMEs' total population is currently 407 million which is 5 per cent more than the EU15 population of 387 million. The 15-64 year old population is 10 per cent larger in the EMEs than in the EU15.

According to the population projections (see Figure 3.3) made by the Eurostat and the US Census Bureau, total EU15 population will be relatively stable during the next 40-50 years peaking at 399 million in 2027 and declining to 384 million in 2050, while that of the EMEs is projected to decline continuously to 361 million in 2050. The steepest relative decline in population between 2006 and 2050 is expected to happen in Bulgaria (-34 per cent), Ukraine (-28 per cent), Russia (-23 per cent) and Romania (-21 per cent), while the only increases are expected in Turkey (+23 per cent), Azerbaijan (+23 per cent) and Albania (12 per cent). A common cultural factor for these latter three countries is that they are the only fully Muslim countries in this study.

By 2050, the share of Russia in the total population of the EMEs is projected to remain the largest, declining from the current 35 per cent to 30 per cent, followed by Turkey (rising from 17 to 24 per cent), Ukraine (declining from 11 to 9 per cent) and Poland (staying at 9 per cent). While the population projections are relatively downbeat for the EU15 countries, they are thus quite dismal for most EMEs.

The changes in terms of age structure are also considerable. The share of the working-aged population in the total EU15 population is projected to decline from a current 66 per cent to 61 per cent in 2030 and 56 per cent in 2050. In the EMEs it is projected to fall from 71 per cent to 67 per cent in 2030 and 61 per cent in 2050. The average fall is thus ten percentage points in both regions.[8] However, this approach does not consider whether the remainder of the population is predominantly below 15 years of age or above 64 years of age.

While the total EU15 population is projected to decline by 1 per cent by 2050, the number of 15-64-year-old people may decline by 16 per cent. In the EMEs, the decline in total population may be 11 per cent, but that of the working-aged population 25 per cent. Here again the differences between the countries are very large: Bulgaria (-48 per cent), Ukraine (-40 per cent), Russia (-36 per cent) and Romania (-34 per cent) with declines in the other countries also except in Azerbaijan (+21 per cent), Turkey (+13 per cent) and Albania (+5 per cent). The latter three are expected to experience a gradual decline in the 2040s, however.

These developments will put the EMEs on very different population and GDP growth paths. The relative decline in the EME populations caused both by a highly negative natural growth rate and emigration may have a positive impact on the convergence of GDP per capita, although it may not be the case if those who emigrate are the young and educated. On the other hand, it will have a negative impact on aggregate GDP in the EMEs. Furthermore, as the populations will grow older, there may also arise opposition to structural economic and other reforms and this may affect the countries' growth adversely.

Below in Section 7.1 we discuss whether the use of the working-aged population as a proxy for labour input is a good choice, how the development of employment may differ from the population projections, and how the level of human capital and its future development could affect future growth.

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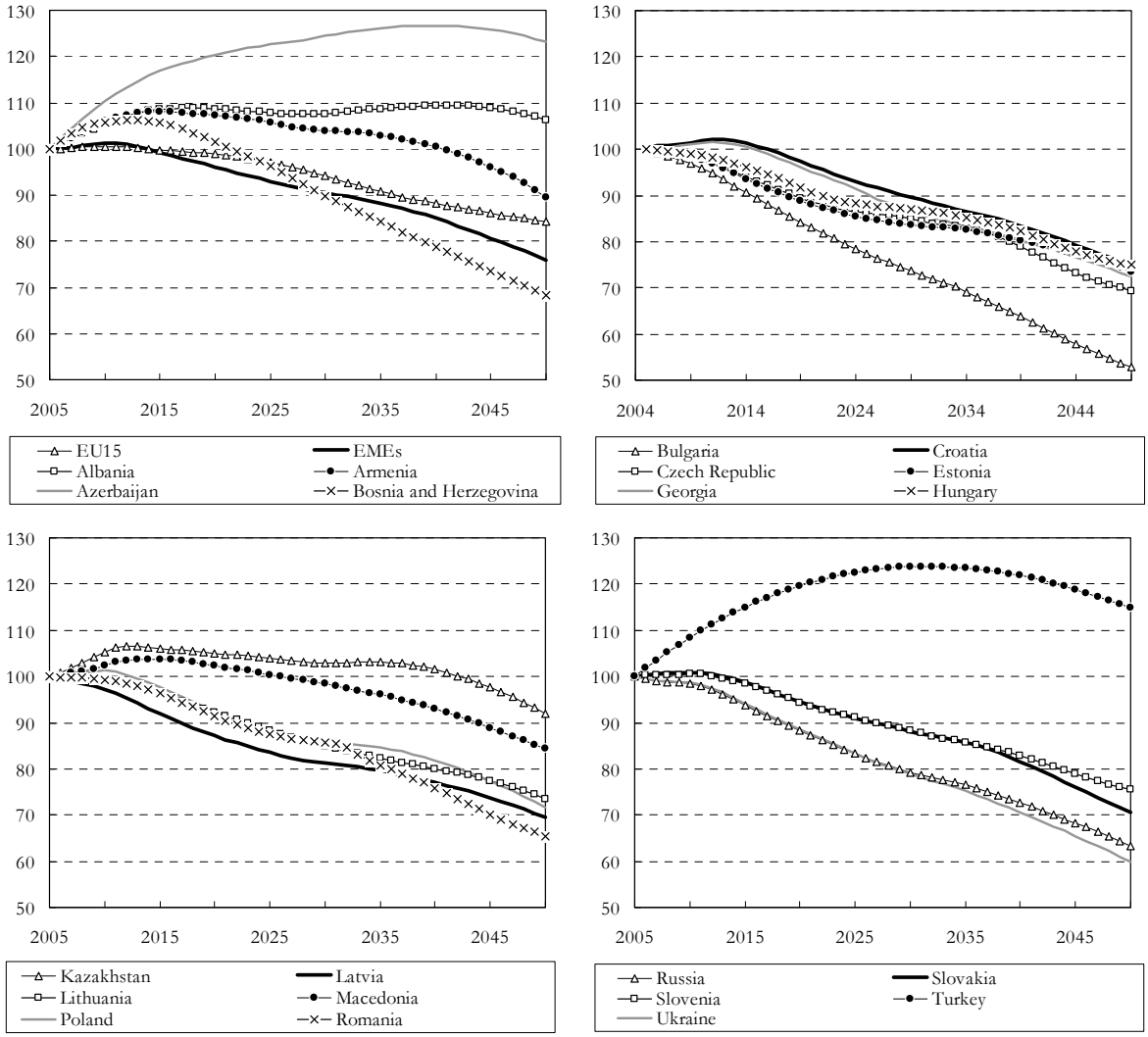
[8] The decline in this ratio is larger than in the EU15 in ten of the EMEs: Bosnia-Herzegovina, Bulgaria, the Czech Republic, Hungary, Poland, Romania, Russia, Slovakia, Slovenia and Ukraine. In our growth projection, these countries' convergence is affected negatively by the weaker development in the share of labour in total population.

Figure 4.3 Population (aged 15-64 years) projections for the EU15 and EMEs, 2005 = 100



Sources: Eurostat for the EU countries; US Census Bureau for the other countries.

5 MODELLING NOMINAL CONVERGENCE

Above we have constructed a framework to project the development of purchasing-power adjusted GDP into the future. However, we also need to take into account nominal convergence. Price levels are typically lower in countries that are less developed in economic terms than in more mature and wealthy economies (see Figure 2.3).

If countries with lower income levels catch up with wealthier countries by growing faster, they typically also experience higher average inflation. This will eventually lead to convergence in price levels. This is also happening in the EMEs. This results in a real appreciation of their currencies with respect to the EU15 currencies through the so-called Balassa-Samuelson effect.

The Balassa-Samuelson effect comes from the difference in relative productivity of the open (or tradable) and sheltered (or non-tradable) sectors. Real appreciation can arise either through faster rise in prices and/or a nominal appreciation of the EME currencies. In the case of Slovenia which already is in the Euro Area, real appreciation can only come about through higher average inflation.

Productivity grows faster in the open sector which is typically thought to consists of manufacturing industries than in the sheltered sector that mainly consists of services. Wages are assumed to rise at the same rate in both sectors as there is a homogenous labour market. The development of open sector prices is given in the world markets because the country is assumed to be small and thus have no pricing power. Because of weaker productivity growth in the sheltered sector, producer prices there will rise faster than in the open sector.

Let the open (tradable) sector be denoted by T and the sheltered (non-tradable) sector by N. The production function in the open sector is, as above, the Cobb-Douglas:

$$Y_T = A_T K_T^{\alpha} L_T^{1-\alpha}, \tag{7}$$

where subscripts refer to the open sector. The wage rate W in the economy is determined by the marginal productivity of labour in the open sector:

$$W = P_T (1-\alpha) A_T \left(\frac{K_T}{L_T} \right)^{\alpha}, \tag{8}$$

where P_T is the price of tradable goods, exogenous to the EMEs.

Assuming a homogeneous labour market, the wage rate in the sheltered sector is the same as in the open sector. The sheltered sector prices its output Y_N on the basis of unit costs. Thus, leaving unessential constants aside, sheltered sector prices are given by

$$P_N = \frac{W^{\mu} \kappa^{1-\mu}}{A_N} \tag{9}$$

where κ is the unit cost of capital, A_N is TFP in the sheltered sector, and μ is the share of labour and $(1-\mu)$ the share of capital in the unit cost.[9] The overall price level P on GDP in the country is given by

$$P = P_T^{\theta} P_N^{1-\theta}, \tag{10}$$

where θ $(0 < \theta < 1)$ is the share of the open sector in domestic output.

Next assume that the required rate of return on capital in the sheltered sector is the same as that in the open sector, that is the value of marginal productivity of capital. It can be derived from (7) in the same way as (8):

$$\kappa = P_T \alpha A_T \left(\frac{K_T}{L_T} \right)^{\alpha-1}. \tag{11}$$

Inserting equations (8) and (11) into (9) and this further into (10) we get, again leaving unessential constants aside, the overall price level as a function of the international price level:

$$P = P_T \left[\frac{A_T}{A_N} \left(\frac{K_T}{L_T} \right)^{\alpha+\mu-1} \right]^{1-\theta}. \tag{12}$$

[9] The specification means that in the sheltered sector, too, the production function is of the Cobb-Douglas type.

Assuming finally that the two production sectors are roughly similar in their cost structures so that $\mu = 1-\alpha$, we get the final expression:

$$P = P_T \left(\frac{A_T}{A_N} \right)^{1-\theta} . \tag{13}$$

This implies that the aggregate price level P rises over time as productivity rises faster in the open sector than in the sheltered sector.[10]

However, there are available no data on TFP in the two sectors in the EMEs. Consequently, we had to take a roundabout way to empirically specify equation (13). The relative price level is projected into the future by specifying in (13) that the path of relative productivity, i.e. A_T / A_N, vis-à-vis the EU15 evolves so that relative productivity is a positive function of relative real GDP per capita between each EME and the EU15. As real convergence proceeds, it is typically based on the fact that productivity in the open sector grows more rapidly than in the sheltered sector so that the price level in the EMEs converges at the same time with that in the EU15.

In order to ensure consistency in the sense that the price level of the EMEs finally converges with that in the EU15, we can write (13) to apply similarly also for the EU15 and take P_T to be the international price level. Thereby as the levels of TFP in the EMEs, both in the open and sheltered sectors, finally converge with those in the EU15 area, also nominal convergence will come to a steady-state equilibrium with respect to the EU15.

Based on this idea, we estimate how relative GDP per capita levels explain relative price levels in the EU15 countries (less Luxembourg) and the EMEs. According to the results

$$\frac{P_{EME,t}}{P_{EU15,t}} = \underset{(0.010)}{0.134} + \underset{(0.013)}{0.851} \left(\frac{y_{EME,t}}{y_{EU15,t}} \right), \tag{14}$$

where P is the price level and y is purchasing-power adjusted GDP per capita. The initial price level in the EMEs relative to the EU15 average is given by the ratio between the purchasing power parity exchange rate and the current exchange rate. Standard errors are shown in parenthesis under the estimation results. The t-statistics are extremely high, 13.7 for the constant and 64.4 for the income gap, and $R^2 = 0.92$. The estimated time period is 1995-2005. For the CIS countries, Albania, Bosnia-Herzegovina, and Macedonia the time period is 2000-2005. Equation (14) still leaves a small gap between the true price level in 2005 and the one that we get from this equation. We assume that this difference will decrease by 5 per cent annually into the future. With this adjustment, when convergence will be finished, also prices will be roughly at the same level as in the EU15 countries as the sum of the two estimated coefficients is very close to unity.[11]

[10] The outcome in equation (13) is the same as that which can be reached by using a simple specification with only one input, labour, in the production functions of both sectors.

[11] We used purchasing-power adjusted GDP per capita in this estimation. Cross sections of the relationship between the price level and current relative GDP in market prices show that it does not matter here whether GDP is purchasing-power adjusted or not.

6 OVERALL UNCERTAINTY AND SENSITIVITY OF RESULTS TO VARIATIONS IN ASSUMPTIONS

6.1 Do countries always converge?

Our setup is such that convergence *will* take place. It should be noted, however, that convergence is not automatic[12] and that there are plenty of examples in economic history of countries that have not converged or have even diverged in terms of GDP per capita relative to more advanced countries. Reasons for relative decline include war, bad political decisions and instability, and unfavourable patterns of export specialisation. It is also possible that for various reasons a country manages to converge up to a point, but then does not manage get past some relative income level. Rodrik (2005), for example, offers a discussion of the different strategies that different countries have used.

Table 6.1 shows how relative purchasing power adjusted GDP per capita has changed with respect to the United States between 1913 and 2003 in selected countries. For example, Ireland's GDP per capita was 51 per cent of the US level in 1913 and it had risen to 85 per cent by 2003, hence the +34 figure shown in the table. We can see that there have been many countries in West Europe that have caught up with the USA between 1913 and 2003 although there are also exceptions, notably the United Kingdom.

Table 6.1 Change in purchasing power adjusted GDP per capita in selected countries with respect to the United States between 1913 and 2003, percentage points

Country	Catching up	Country	Catching up	Country	Catching up
West Europe					
Ireland	+34	Italy	+18	Germany	-3
Finland	+31	Greece	+17	Switzerland	-4
Portugal	+24	France	+10	United Kingdom	-19
Spain	+20	Austria	+8		
EMEs					
Turkey	0	Poland	-6	Hungary	-12
Albania	-4	Bulgaria	-7	Romania	-21
Czechoslovakia	-6				
Asia					
Japan	+47	South Korea	+38	India	-5
Taiwan	+45	China	+6		
Latin America					
Brazil	+4	Mexico	-8	Uruguay	-39
Venezuela	+3	Chile	-19	Argentina	-45
Africa and Middle East					
Iran	0	Egypt	-7	Algeria	-11
Morocco	-3	Ghana	-10	South Africa	-15

Source: 'Historical Statistics for the World Economy: 1-2003 AD' by Angus Maddison.

The EMEs shown in the table have generally not managed to catch up, but this will change because economic recovery from the socialist system is still continuing. We find successful

[12] See e.g. Durlauf et al. (2005) for a discussion on different countries experiences of growth at different times.

growth development in Asia where a number of countries have converged considerably towards the USA, and countries, e.g. in Africa and Latin America, that have grown slower than the USA during the past 90 years despite their lower initial income levels.

In our concise framework we cannot take into account the diversity of possible shocks, positive or negative, that may affect the countries and their speed of GDP per capita convergence. Among other things, we abstract from the structure of institutions and political uncertainty that may be significant especially in those countries that are not members of the EU and are not likely to become such. The EU membership process of the past decade has provided an anchor for the accession countries in terms of legal system, institutions and democracy that should not be underestimated. Many of the EMEs in our study that are not EU member countries are autocracies or have weak democracies that may also hurt their investment climates and thus long-term growth.

6.2 Uncertainty in long-term growth projections

We will only take into account one form of uncertainty. It relates to the growth rate of total factor productivity.[13] As can be seen from the results, taking into account just this one form of uncertainty can make a big difference. On the basis of the above growth model, we can write the aggregate real income growth g in a country at time t, this time in logarithmic change form, approximately as

$$g_{EME,t} = \Delta \log y_{EME,t} = \frac{1}{1-\alpha} \Delta \log A_{EME,t} + \varepsilon_{EME,t}, \tag{15}$$

where y is GDP per capita and ε_{EME} is a stochastic error term. Let again $a_t = \log A_t$. Then $\hat{a}_t = a_t - a_{t-1}$ is the growth rate of TFP. As specified above in (2),

$$\hat{a}_{EME,t} = \hat{a}_{EU15,t} - \beta \log\left(\frac{y_{EME,t-1}}{y_{EU15,t-1}} \right). \tag{16}$$

The growth rate of per capita income in the EU15 (g_{EU15}) can be written similarly as in (15).

On the basis of (15) and (16) we can conclude that the logarithm of relative GDP per capita evolves over time as follows:

$$\begin{aligned} \log\left(\frac{y_{EME,t}}{y_{EU15,t}} \right) &= \log\left(\frac{y_{EME,t-1}}{y_{EU15,t-1}} \right) + g_{EME,t} - g_{EU15,t} \\ &= \left(1 - \frac{\beta}{1-\alpha} \right) \log\left(\frac{y_{EME,t-1}}{y_{EU15,t-1}} \right) + \varepsilon_{EME,t} - \varepsilon_{EU15,t} \end{aligned} \tag{17}$$

The variance V related to the GDP-per-capita gap now evolves recursively (see also Barro and Sala-i-Martin 1995, 384) in the following way:

$$V\left(\log\left(\frac{y_{EME,t}}{y_{EU15,t}} \right) \right) = \left(1 - \frac{\beta}{1-\alpha} \right)^2 V \log\left(\frac{g_{EME,t-1}}{g_{EU15,t-1}} \right) + \sigma^2_{g,EME} + \sigma^2_{g,EU15} \tag{18}$$

[13] Alho et al. (2005) use this type of measurement for uncertainty in their growth model.

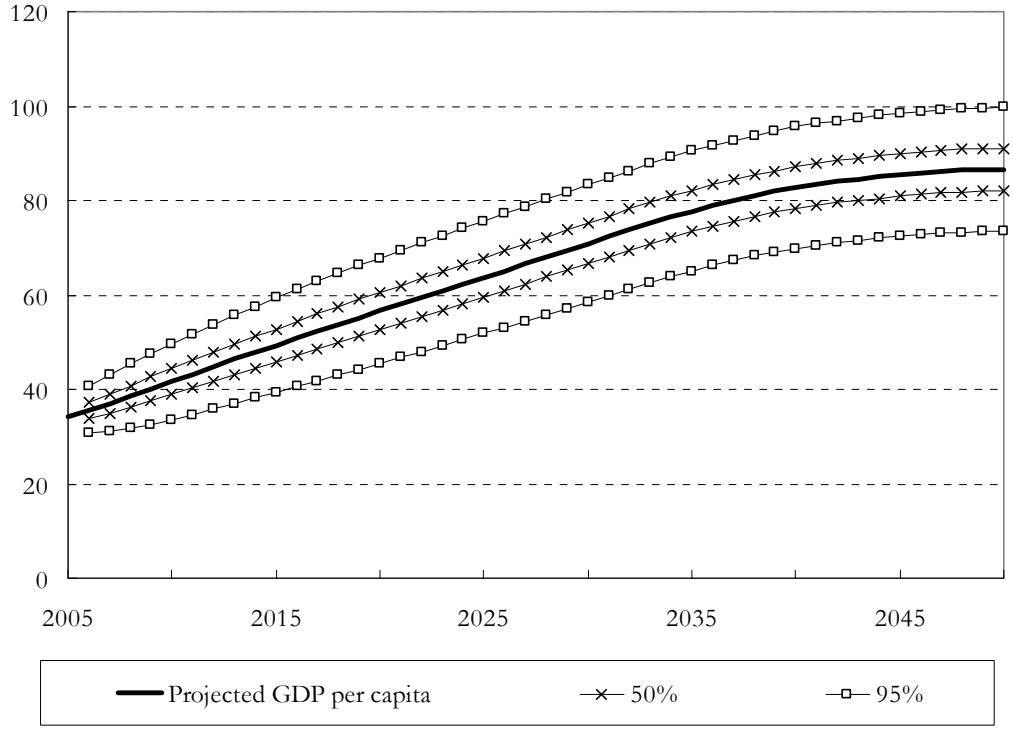
In the first period $V\log\left(\frac{y_{EME,1}}{y_{EU15,1}}\right)=\sigma^2_{g,EME}+\sigma_{g,EU15}$. We have also assumed in (18) that the uncertainty related to the EU15 countries' growth path (g_{EU15}) is uncorrelated with that in the EMEs (g_{EME}), which is a simplifying assumption. In the numerical evaluation, this stochastic projection is demonstrated for the EMEs on average. The point is to show the size of uncertainty related to the growth path.

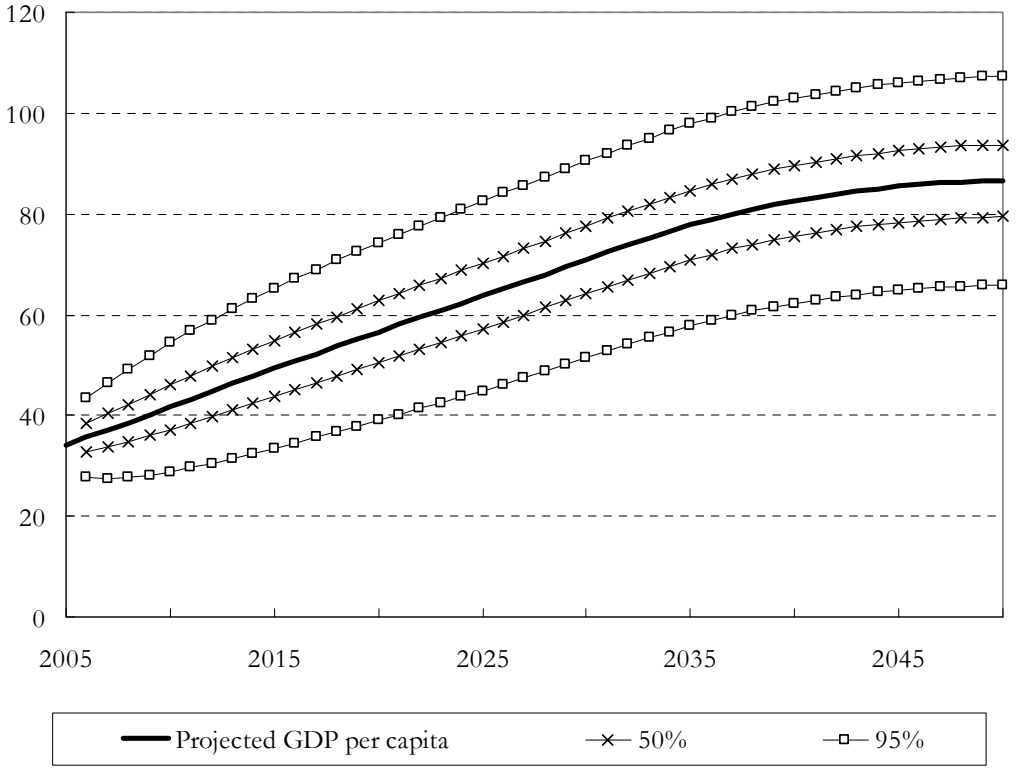
The assumption of β convergence dampens the accumulation of uncertainty. Namely, if there is a positive impulse to growth in year *t*, this will dampen the growth rate from $t+1$ onwards. Over a longer historical time period $\sigma_{g,EU15}=0.013$. During the beginning of this decade, σ_g has not deviated from this for a group of EMEs that covers most of these countries. It can also be expected that as convergence proceeds also growth rates will not be as volatile as they were in the 1990s. Consequently, we will use σ_g = 1.3 percentage points for both the EU15 countries and the EMEs. However, as some of the EMEs have continued to have a more volatile GDP growth rate, we also make a projection of the uncertainty with a twice-as-high uncertainty in the EMEs, i.e. $\sigma_{g,EME}$ = 2.6 percentage points.

The cumulative uncertainty is calculated on the basis of (18). Figure 6.1 shows the uncertainty related to real GDP per capita convergence in the above two cases for the average of the EMEs in 2000-2050. There are two confidence limits, one which shows the band in which GDP per capita will be with a probability of 50 per cent, and another which shows it with a probability of 95 per cent. As we see from the graph, the average uncertainty related to long-run growth projections is considerable. With the same volatility in the two regions, the confidence band is ±13 percentage points. It rises to ±21 percentage points if we assume a double variance in the EMEs.

Other forms of uncertainty that we do not take into account here, relate to, among other things, the population projections that we take as given from the Eurostat and the US Census Bureau, and the possible impact of climate change on long-term growth.

Figure 6.1 **Uncertainty related to long-run real GDP per capita convergence with the volatility of growth the same in the EU15 and the EMEs (above) and with twice as high volatility in the EMEs as in the EU15 (below), see text**





6.3 Sensitivity of results to variations in assumptions

Above we have made assumptions of certain constants and variables and estimated others. In this section we will review how the results would change if we were to change some of these assumptions. This is a way of checking how robust the results are to changes in the assumptions. Of course also the model structure imposes its own limitations, but we do not analyse how the results would change if the structure of the model were changed.

Figures 6.2-6.4 show how the average EMEs' convergence of real GDP per capita will change given changes in the assumptions. Every time, only one assumption is changed while the others remain unchanged. Figure 6.2 shows what effect the choice of β has on the results. If we choose $\beta = 0.015$, as Wilson and Purushothaman (2003) do, the EME average in 2050 will be 14 percentage points below the results we get with our baseline where $\beta = 0.025$. Choosing $\beta = 0.035$ would result in an 8 percentage point higher relative GDP per capita level in the EMEs. However, 0.035 would be a very high figure. Different βs for different countries could be argued for on the basis of, among other things, different levels of human capital (see Section 7.1).

Figure 6.2 The effect of choosing a different β on real GDP per capita convergence, EU15 = 100

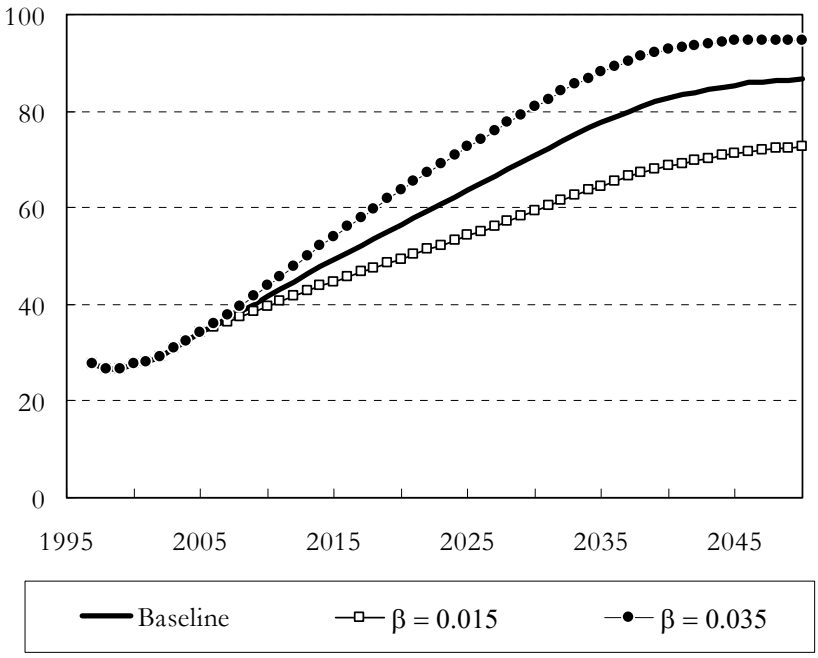
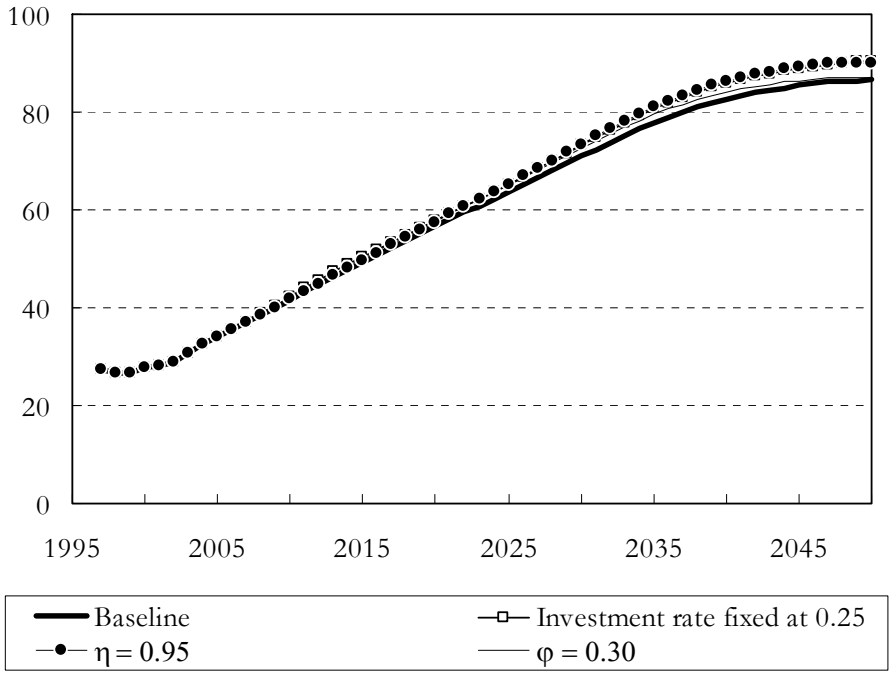


Figure 6.3 shows the effect that changing the EMEs' investment behaviour, which would affect the capital stock, would have on the results. The investment rate in the EU15 countries remains as above. We can see that raising the investment rate from an average 20.7 per cent to a constant 25 per cent has very little effect on the rate of real convergence. After 45 years of an over 4 percentage points higher savings rate, the EMEs relative GDP per capita would be only 3.8 percentage points higher than with the lower investment rate. However, this would raise the capital-stock-to-GDP ratio from 3.1 in 2050 to 3.7, which would be quite a high figure and would imply considerable capital deepening beyond that in the EU15. In 2050, the EU15 countries' K/Y ratio is projected to be 3.2. A ratio of 3.7 for the EMEs on average might be difficult to justify.

Raising η in equation (6) from 0.88 to 0.95 would raise the average investment rate to 24.6 per cent and the relative GDP per capita level by 3.5 percentage points. Finally, raising φ from 0.20 to 0.30 would raise the relative GDP per capita level by just 0.5 percentage points. In this model, the differences in the investment rate thus have quite a limited impact on the results.

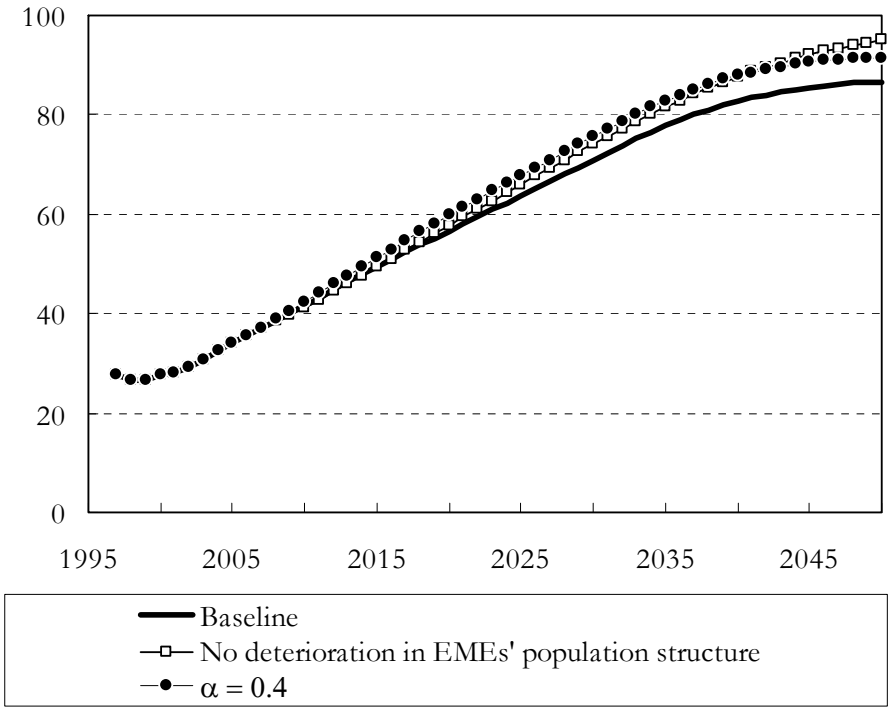
Figure 6.3 The effect of changing the investment behaviour on real GDP per capita convergence, EU15 = 100



On average, the share of the working-aged population in total population will decline by 10 percentage points in both the EU15 and the EMEs, although there are considerable differences especially between the latter countries in this respect. Changing the ratio between the two population figures makes a considerable difference in the model. If the share of the working-aged in the EMEs' population would not change after 2006, while it would continue to decrease in the EU15 countries, the gap in relative GDP per capita would be over 8 percentage points smaller in 2050. The effect would be much larger in some EMEs than in others because of the very diverging population developments.

The elasticity of output with respect to capital, i.e. the share of capital in total income or α, also makes some difference. If we assume that α is 0.40 instead of 0.33 then the GDP per capita gap declines by almost 5 percentage points. Note that α affects the production function of both the EU15 and the EMEs in the same way.

Figure 6.4 The effect of population structure and the share of capital in total income for the results on real GDP per capita convergence, EU15 = 100



7 SPECIAL FACTORS

There are a number of issues that cannot be introduced into our relatively straightforward model. Some of these issues and their future projections are discussed in this section. First we discuss the labour force and human capital. Then in Section 7.2 we discuss the current and future importance of energy commodities for Russia, Kazakhstan and Azerbaijan and what implications this may have.

7.1 Employment rate and human capital

We have taken labour from population projections produced by the Eurostat and the US Census Bureau, and we make no modifications to these. There are a few issues that need to be discussed here. These are our definition of labour (or employment), and how human capital may develop.

For labour we use available projections of working-aged population aged 15-64 years. It is a standard approach to use population data in convergence research. However, this is not quite the same as using actual employment. We make the tacit assumption that employment rates will not change in the future, as do also Wilson and Purushothaman (2003). If employment rate were to change in the future by as much in the EMEs as in the EU15, our results would not be affected. However, if employment rates were to evolve differently in the countries, it would also affect the results. A change in employment rates could come about through a change in unemployment and/or participation in the labour force. An additional

factor is the average number of hours worked which may differ considerably between countries.

Some of the EMEs have quite low employment rates (see Table 7.1), and we could expect that these will rise in the future. Such countries are Albania, Armenia, Croatia, Georgia, Hungary, Poland, Slovakia, Macedonia and Turkey. A rise in the employment rate would increases the labour input and boost GDP and GDP per capita growth.

However, a few caveats should also be kept in mind. First, there may be statistical discrepancies in the data due to, among other things, shadow employment or underemployment. Second, culture plays a significant role in this question. In the EU15, employment rates (especially those of women) are lower in the south of Europe than in the north of Europe.[14] As most of the EMEs with the lowest employment rates are in the south of Europe, it may very well be that the potential for higher employment rates is smaller than one would think if the reasoning is based simply on a comparison with the EU15 average. On the other hand, culture may of course change in this respect given the relatively long time span of our projections.

Table 7.1 Employment rates in the EMEs in 1995 and 2005 (%), change in 1995-2005 (%-points), and difference to the EU15 in 2005 (%-points)

Country	1995	2005	Change 1995-2005	Difference to EU15 in 2005
EU15	62.1	67.4	5.3	0.0
Albania	58.5	46.0	-12.5	-21.4
Armenia	73.6	54.2	-19.4	-13.2
Bulgaria	58.3	61.0	2.6	-6.5
Croatia	..	52.6	..	-14.8
Czech Republic	73.1	69.0	-4.0	1.6
Estonia	67.2	65.8	-1.5	-1.7
Georgia	54.9	58.4	3.5	-9.0
Hungary	51.7	55.7	4.0	-11.8
Kazakhstan	..	70.1	..	2.7
Latvia	58.9	65.1	6.2	-2.3
Lithuania	..	63.7	..	-3.8
Poland	58.0	52.3	-5.7	-15.2
Romania	70.0	60.6	-9.4	-6.9
Russia	64.8	67.1	2.3	-0.3
Slovakia	59.0	54.1	-4.9	-13.3
Slovenia	66.1	65.0	-1.1	-2.4
Macedonia	..	38.7	..	-28.8
Turkey	54.7	46.5	-8.1	-20.9
Ukraine	..	63.6	..	-3.8

Source: WDI.

[14] According to WDI data, the share of women in the labour force in 2005 was the lowest in Turkey (26 per cent), Macedonia (39 per cent), Albania (42 per cent), Georgia (43 per cent), and Croatia, Hungary, Slovakia and the Czech Republic (45 per cent). On the other hand, of all the individual EU15 countries and the EMEs in this study, women's share in total employment is the highest in Kazakhstan, Estonia, Armenia, Lithuania, Ukraine, Russia, Latvia and Bosnia-Herzegovina. Only then do we find the first EU15 countries, Finland, Sweden and Denmark. Besides, Luxembourg, Spain, Greece and Italy are below Albania in this respect.

Data allowing, labour input should be measured in hours, not by the number of people employed. According to the GGDC database,[15] the average number of hours worked in the EU15 countries in 2005 was 1,562 hours, while the corresponding figure was higher than this in Estonia (2,011 hours), Poland (1,994), Romania (1,979), the Czech Republic (1,940), Turkey (1,918), Latvia (1,909), Lithuania (1,855), Hungary (1,804), Slovakia (1,741), Slovenia (1,727), and Bulgaria (1,703). Thus for all the EMEs we have data for the average number of hours worked was higher than the EU15 average which of course also includes a lot of variation between the EU countries. Based on the number of people, not working hours, we thus get too high figures for relative labour productivity in the EMEs in this study. If the average number of hours worked in the EMEs will decline in the future, for example because as people become wealthier they may start to value leisure time more than before, employment (when measured in hours) will decline. This would have an opposite effect than the employment rate may have.

In our framework, the quality of the labour force is reflected in total factor productivity. A factor that we do not directly take into account is the level and expected relative growth rate of human capital vis-à-vis the EU15. Low levels of education are likely to indicate that the country will not be able to adopt modern technology and business management techniques and thus its TFP growth rate will remain low, maybe lower than in more advanced countries. Then there would be no income convergence either. If the country has a very low GDP per capita starting level, then even a moderately low level of education may suffice for GDP convergence. But as the country grows wealthier it will need to move from copying best practices to becoming more innovative and then low levels of education will not suffice.[16]

Table 7.2 shows data on the levels of educational attainment in these countries and the EU15. However, it is difficult to draw strong views from this for the GDP growth rate. We also do not know to what extent the quality of education differs across the countries. Furthermore, there are a number of countries for which we do not have data.

The labour force in Georgia has very little secondary education, whereas Romania, Slovakia, the Czech Republic, Poland, Hungary, Slovenia and Croatia would seem to have a relatively low level of tertiary education. On the other hand, Russia, Lithuania and Georgia seem to have a very high prevalence of tertiary education in their labour force.[17] However, there is still time to educate younger generations, and for this we need to look at different data.

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[15] The Conference Board and Groningen Growth and Development Centre, Total Economy Database, http://www.ggdc.net.

[16] In Poncet (2006), the TFP growth rate projected into the future is a function of the average years of education, and the product of the average years of education and the income gap compared with the United States. As a consequence, the differences in TFP growth projections between countries become very large. Taking into account expected improvement in education, Poncet projects the average annual TFP growth in 2005-2050 in Romania and Bulgaria as 1.8 per cent, Poland as 1.6 per cent, the Czech Republic and Hungary as 1.5 per cent, Slovenia as 1.0 per cent, and Turkey as 0.9 per cent. These are significantly below our projections. Our projection is 2.8 per cent for Romania and Bulgaria 2.4 per cent for Poland, 2.2 per cent for Hungary, 2.1 per cent for the Czech Republic, 1.9 per cent for Slovenia, and 2.9 per cent for Turkey. On the other hand, the figure from our model for Finland is 1.4 per cent, the same as Poncet's. In Poncet's study the treatment of TFP makes a huge difference. The highest TFP growth rates are in the Philippines (averaging 3.1 per cent in 2005-2050) and China and Thailand (2.8 per cent), while five African countries are projected to have a slightly negative average TFP growth rate.

[17] According to WDI statistics, 42 per cent of the labour force in Georgia have a tertiary education, but 55 per cent of total employment is in agriculture.

Table 7.2 Labour force with secondary and tertiary education in 2001, % of total

Country	Secondary education	Tertiary education	Secondary or tertiary education
EU15	48.4	22.2	70.5
Bulgaria	55.0	23.3	78.3
Croatia	60.4	17.2	77.6
Czech Republic	78.1	11.6	89.7
Estonia	57.8	30.7	88.5
Georgia	7.2	41.8	49.0
Hungary	65.2	16.5	81.7
Latvia	62.4	19.9	82.3
Lithuania	37.5	46.0	83.5
Poland	71.8	12.9	84.7
Romania	57.1	9.1	66.2
Russia	33.9	54.0	87.9
Slovakia	79.6	11.5	91.1
Slovenia	62.3	16.6	78.9

Note: Russia in 1998 and Georgia in 1999. EU15 is the simple average of France, Germany, Italy and the United Kingdom.
Source: WDI.

The next table shows gross school enrolment data for almost all the EMEs. Secondary school enrolment may be too low in Albania, Turkey, Georgia, Macedonia, Romania and Croatia, while tertiary enrolment is relatively low in Albania, Armenia, Macedonia and Turkey, but also Bulgaria, Croatia, the Czech Republic, Georgia, Kazakhstan, Romania and Slovakia. If educational attainment is low, also growth prospects are weaker in the medium to long term. Tertiary enrolment is particularly high in Latvia, Slovenia, Lithuania, Russia, Ukraine and Estonia. Again it should be noted that these data do not reveal any information on the quality of the education.

Table 7.3 Secondary and tertiary school enrolment in 2004, % gross

Country	Secondary	Tertiary	Country	Secondary	Tertiary
EU15	103.6	59.7	**Latvia**	96.6	74.3
Albania	77.8	16.4	**Lithuania**	98.1	73.2
Armenia	91.4	26.2	**Macedonia**	84.1	28.0
Bulgaria	102.1	41.1	**Poland**	96.7	61.0
Croatia	88.2	38.7	**Romania**	85.1	40.2
Czech Republic	95.7	43.2	**Russia**	92.9	68.2
Estonia	98.1	65.1	**Slovakia**	94.2	36.1
Georgia	82.3	41.5	**Slovenia**	99.8	73.7
Hungary	96.5	59.6	**Turkey**	79.2	29.0
Kazakhstan	98.1	48.0	**Ukraine**	92.9	65.5

Note: Albania and Croatia in 2003. EU15 is the simple average of France, Germany, Italy and the United Kingdom. EU15 for tertiary enrolment is without Germany.
Source: WDI.

Combining the educational data in these two tables we argue that, unless the EMEs start to put more focus on education, the speed of real GDP convergence calculated above is probably too high for Albania, Macedonia and Turkey, but the situation is also worrying in terms of secondary education in Georgia and possibly in Romania and in terms of tertiary education in Armenia, Croatia, the Czech Republic, Romania and Slovakia.

It would thus seem that the least wealthy countries that have the lowest employment rates and maybe most to gain in growth prospects in that respect also have the lowest educational levels and the lowest school enrolment rates. This is logical in the sense that low levels of human capital also produce low productivity and low incomes. Our projections are so far into the future that the governments in the EMEs have ample time to change these structural weaknesses. However, this also depends on, among other things, the financial resources the governments have at their disposal as well as the governments' political will and capability.

7.2 Oil and gas sectors in Russia, Kazakhstan and Azerbaijan

The development in world market commodity prices and the energy raw materials has been very important in view of economic growth in Russia, Kazakhstan and Azerbaijan. How the world markets will develop in the future will also affect the growth prospects of these three countries.

According to British Petroleum, at the end of 2006 Russia had proved oil reserves[18] left 79.5 billion barrels (6.6 per cent of world total) and its R/P ratio (reserves-to-annual-production ratio) was 22.3. At the end of 2006 Kazakhstan's proved oil reserves were 39.8 billion barrels (3.3 per cent of world total) and its R/P ratio was 76.5, while Azerbaijan's reserves were 7.0 billion barrels (0.6 per cent of world total) and its R/P ratio was 29.3. However, estimates of proved reserves contain a lot of uncertainties. Nevertheless, it should be fairly safe to say that, with present geological knowledge, Russia and Azerbaijan may run out of crude oil during the time span of our projection.

Natural gas is a different story. At the end of 2006 Russia had proved natural gas reserves left 47.65 trillion cubic metres (26.3 per cent of world total) and its R/P ratio was 77.8 years. Kazakhstan has 1.7 per cent of world total and Azerbaijan 0.7 per cent. Their R/P ratios are above 100. These countries should therefore not be running out of natural gas deposits with current production volumes.

Considerable reliance on energy commodities may lead to so-called Dutch disease. The inflow of export revenues, boosted by rising export prices, as has happened during the past decade, will lead to a real appreciation of the exchange rate. If the real exchange rate appreciates too much, the country's manufacturing industry may lose its competitiveness in the global market. If export revenues then fall, either through a decline in world market prices or a decline in extraction, the country may have to resort to a considerable devaluation of its currency. This would also mean a large decline in the purchasing power of the consumers. As the world market prices of energy commodities are notoriously volatile and also because Russia and Azerbaijan may run out of crude oil, these countries run the risk of larger volatility in their real exchange rates and GDP growth rates than the other countries in our study.

[18] The proved reserves of oil are those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions.

8 RATE OF RETURN ON CAPITAL AND THE STOCK MARKET

8.1 Rate of return on capital

The valuation of capital in the stock market is given by forward-looking investment behaviour as a function of expected dividends. Let q be the stock price, which is now given by the following standard asset pricing equation:

$$q_t = d_t + \left(1 + r_t\right)^{-1} q_{t+1} \ . \tag{19}$$

where d is dividend and r is the financial interest rate. The stock market reflects the current and future profitability of the firms listed there.

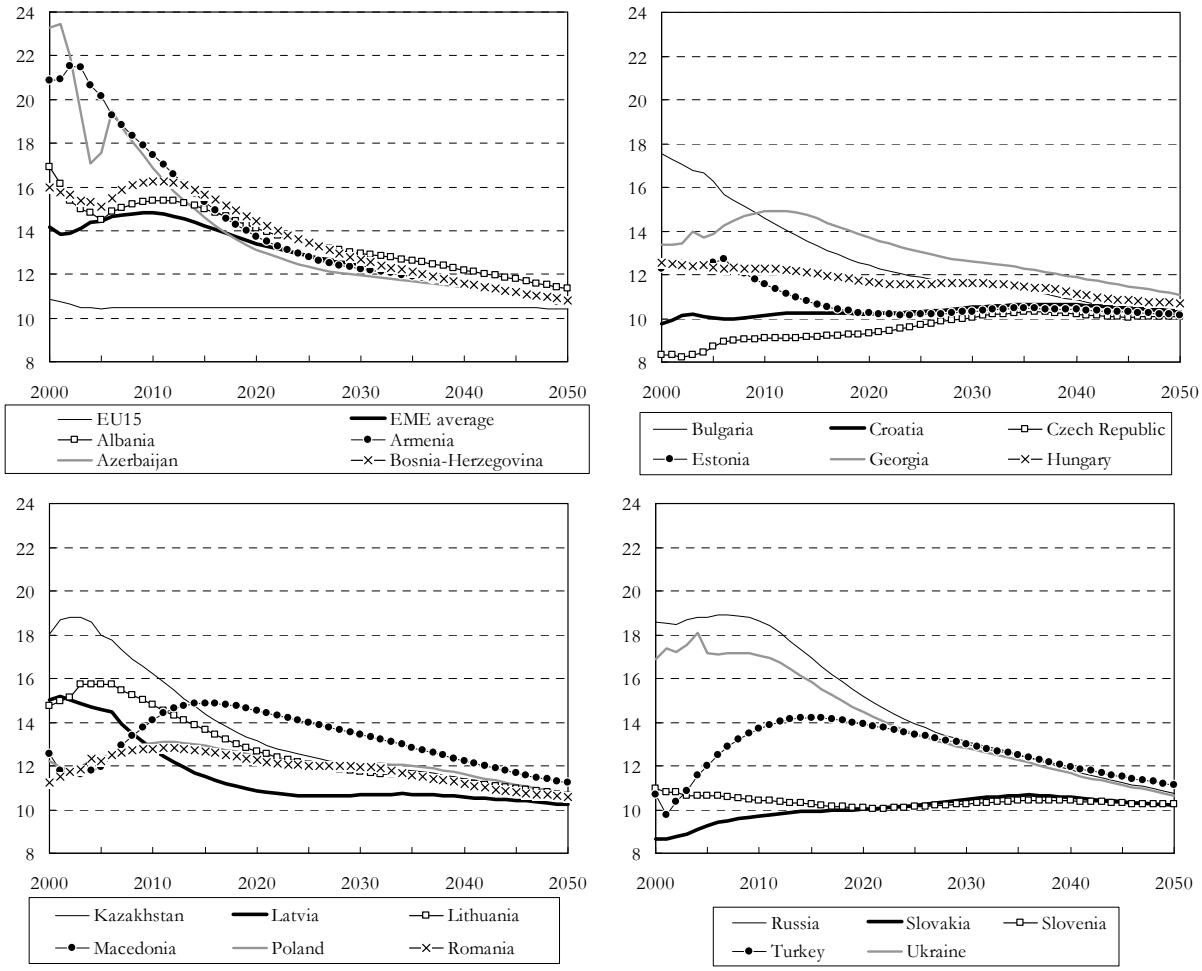
Dividends are based on the profitability of firms, which is the rate of return on capital. The real rate of return before corporate and capital income taxes is given for the whole economy by equation (11) which is reproduced here for convenience:

$$\frac{\kappa}{P_T} = \alpha A_T \left(\frac{K_T}{L_T}\right)^{\alpha-1} \ .$$

Thus the rate of return is high if the level of total factor productivity is high and the capital-to-labour ratio is low. TFP rises in the EMEs so this will tend to raise the rate of return on capital. On the other hand, the countries will become more capital intensive and this will lower the rate of return on capital. As we see from Figure 8.1, the latter dominates in the long run and the rate of return on capital tends to decline in the EMEs. With the values we have chosen, the rate is very stable at 10.5 per cent in the EU15. As A and the capital-to-labour ratios in the EMEs converge with those in the EU15, also the rates of return on capital will converge with the rate in the EU15.

There are a couple of countries, namely the Czech Republic and Slovakia, where the real rate of return is quite low all the time. This is because we get very high initial capital intensities for these countries due to a combination of a high historical investment rates and relatively low GDP growth.

Figure 8.1 Projected real rates of return on capital in the EU15 and the EMEs, %



According to ABN AMRO (2006), the average real returns on equities in 16 industrialised countries (see Table 8.1) in 1900-2005 have varied between 2.4 per cent in Belgium and 7.8 per cent in Sweden. Although all the countries shown here are developed there are huge long-term differences between the rates of real return. Over a time span of a hundred years, the difference between the fastest and the slowest growth cumulates to massive differences.

Table 8.1 Average annual real returns on equities in 16 industrialised countries in 1900-2005

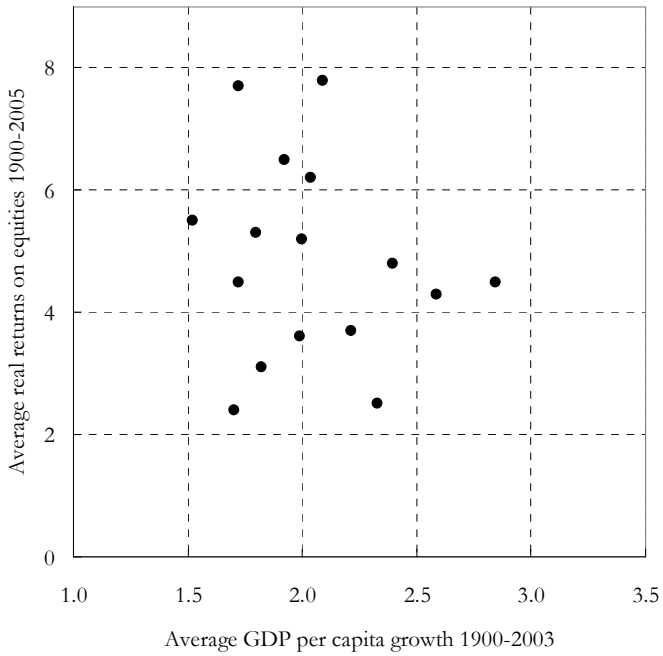
Country	Average increase	Country	Average increase
Belgium	2.4	**Ireland**	4.8
Italy	2.5	**Denmark**	5.2
Germany	3.1	**Netherlands**	5.3
France	3.6	**United Kingdom**	5.5
Spain	3.7	**Canada**	6.2
Norway	4.3	**United States**	6.5
Switzerland	4.5	**Australia**	7.7
Japan	4.5	**Sweden**	7.8

Source: ABN AMRO (2006).

Figure 8.2 shows that there is practically no correlation between the average GDP growth rate and the average rate of return on equity in these countries. The R^2 value is almost zero. If we compare the initial GDP per capita in 1900 it shows the same low degree of correlation with the future real return on equity as GDP per capita does.

On the other hand, for these countries initial GDP per capita and its future growth rate show a strong negative correlation in line with the catching-up process that we project in this study. However, here we should note that the countries in the ABN AMRO study are all successful growth stories. Things could look different if there were countries that have diverged from the US income level.

Figure 8.2 Average GDP per capita growth and average real returns on equities in the long term in 16 industrialised countries



Note: The countries are the same as in Table 8.1. The average GDP growth rate for Ireland is for 1913-2003.
Sources: ABN AMRO (2006) and Angus Maddison.

8.2 Market capitalisation

In 2005, the market capitalisation of stock exchanges in the EU15 countries varied between 39 per cent of GDP in Portugal and 152 per cent in Luxembourg. The simple average over the countries shows that average market capitalisation rose from 29 per cent of GDP in 1992 to 115 per cent in 1999, after which stock markets world wide tumbled and market capitalisation declined to 65 per cent of GDP in the EU15 in 2002 before starting a new rise.

In the new EU member countries that joined either in 2004 or 2007 market capitalisation is considerably lower than in the more advanced EU15 countries. In 2005 it was the lowest in Slovakia (9 per cent of GDP) and the highest in Poland (31 per cent), the Czech Republic (31 per cent) and Hungary (30 per cent). Of the other EMEs, market capitalisation in 2005 was the highest in Russia (72 per cent of GDP) and Turkey (44 per cent), and by far the lowest in Georgia (6 per cent of GDP) and Armenia (1 per cent).

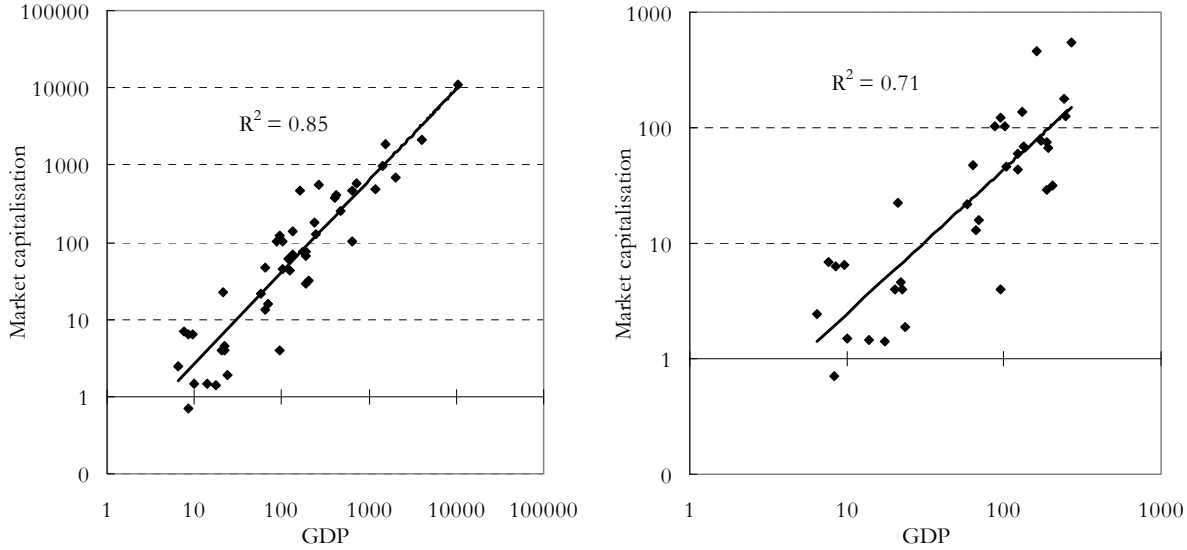
Can we make any future projections as to the future development of market capitalisation? The stock market capitalisation of a firm is its market value, that is, the discounted value of

all its future expected dividends. Thus it is a function of the firm's marginal productivity of capital as shown above. The marginal productivity of capital can be thought to be higher in countries that are not capital intensive. These are typically countries that have low levels of income.

Given free movement of capital the market capitalisation in the stock exchange across a large number of countries will probably be uncorrelated with the level of income in the country. A scatter plot between market capitalisation of listed companies as a percentage of GDP and PPP-adjusted GDP per capita in 2002 for 47 high and upper-middle-income countries yields an R^2 value of just 0.16 for a linear trend.

On the other hand, market capitalisation and total GDP could correlate at least to some degree. Figure 8.3 shows market capitalisation and GDP for a group of 47 countries. Especially when we include the world's largest economies, we find a relatively high R^2 value. It declines somewhat if we remove the 12 largest economies.

Figure 8.3 **Logarithm of market capitalisation and GDP for a group of 47 high and upper-middle-income countries (left) and with the largest economies removed (right), log of bill. current USD in 2002**



Source: WDI.

GDP is the gross value added produced in the country during one year. Notwithstanding the public sector, GDP is produced by firms if we approach it from the production side. To project stock market capitalisation into the future, one would need to know how large a share of all firms contributing to a country's GDP will be valued in the local stock exchange. Some of the value added in the country will be produced by foreign firms listed in some foreign stock exchange. And some of the local firms listed in the local stock exchange will have operations in foreign countries that contribute to the valuation of the firm. Of these the first, that is that foreign companies have a large contribution to GDP, is probably the more significant for most EMEs. Especially in the new EU member countries foreign-owned firms are very dominant in most sectors of manufacturing, banking, retail trade etc. This may of course change as local financial resources and investment capital will increase in the future. On the other hand, as economic integration and technological development will proceed, the map of stock exchanges across Europe 20 or 40 years hence may be very different from what it is today. It should furthermore be noted that foreign portfolio investments may currently not be free in all the non-EU countries in this study.

LIST OF VARIABLES

Level variables

Y	Gross domestic product (GDP)
y	GDP per capita
A	Total factor productivity (TFP)
K	Net capital stock
L	Labour (working-aged population aged 15-64)
I	Gross fixed capital formation (investment)
i	investment rate (investment-to-GDP ratio)
T	Open (tradable) sector
N	Sheltered (non-tradable) sector
W	Wage rate
P	Price level

Elasticities and shares

α	Elasticity of output with respect to capital (0.33)
μ	Share of labour in unit cost
θ	Share of open sector in domestic output

Growth rates

γ	Real GDP growth rate
g	Real GDP per capita growth rate
$\hat{a}$	TFP growth rate (0.015 in the EU15)
n	Population growth rate
λ	Labour (working-aged-population) growth rate

Convergence coefficients

β	Speed of TFP convergence (0.025)
η	Investment equation, lagged investment rate difference to EU15 (0.88)
φ	Investment equation, GDP growth rate difference to EU15 (0.20)

Investment and capital-related constants and variables

δ	Depreciation rate (0.04)
ρ	Steady-state real interest rate (0.051)
κ	Rate of return on capital
d	Real dividend
q	Stock price
r	Financial interest rate

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LÖNNROTINKATU 4 B, FIN-00120 HELSINKI

Puh./Tel. (09) 609 900 Telefax (09) 601753
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