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Gregorčičeva 27, 1000 Ljubljana.
Tel: (+386) 1 478 10 12
Fax: (+386) 1 478 10 70
E-mail: gp.umar@gov.si

dr. Janez ŠUŠTERŠIČ, director

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Egbert L. W. Jongen*

An Analysis of Past and Future GDP Growth in Slovenia

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* CPB Netherlands Bureau for Economic Policy Analysis and Institute for Economic Research. This paper was written while I was visiting IMAD. I gratefully acknowledge their hospitality.

Contents

Povzetek

Po začetnem padcu se je bruto domači proizvod na prebivalca v Sloveniji v devetdesetih letih močno okrepil.V obdobju od leta 1993 do leta 2002 je bila povprečna letna stopnja rasti 4.1-odstotna. Da bi ugotovili, kateri so bili glavni dejavniki rasti, smo oblikovali časovno serijo za fizični in človeški kapital. Izbrana serija za fizični kapital (osnovna sredstva) je v obdobju 1993–2002 rasla po letni stopnji 6.8%, kar kaže na precejšnje kapitalsko poglabljanje. Izbrana serija za človeški kapital je rasla po letni stopnji 1.6%, pri čemer smo uporabili širšo definicijo človeškega kapitala, ki vključuje tudi tehnološki napredek, usmerjen k visoko izobraženim delavcem (skill biased technological change).

S pomočjo serije za fizični in človeški kapital ter podatkov o zaposlenosti in rasti proizvodnje smo z metodo ocenjevanja prispevkov k rasti določili pomen posameznih proizvodnih dejavnikov za gospodarsko rast v obdobju 1993–2002 ter rast reziduala oziroma skupne faktorske produktivnosti (tehnični napredek). Ugotovili smo, da so delo (zaposlenost), človeški kapital, fizični kapital in skupna faktorska produktivnost h gospodarski rasti v povprečju prispevali 0.1, 1.1, 2.0 in 0.8 odstotne točke. Prispevek zaposlenosti je bil nizek, ker je bila rast dela kot proizvodnega dejavnika v izbranem obdobju zanemarljiva. Po prispevku h gospodarski rasti je bil na prvem mestu fizični kapital in na drugem mestu človeški kapital, ker je bila rast fizičnega kapitala hitrejša od rasti človeškega kapitala, čeprav ima sicer človeški kapital v proizvodnji večjo utež. Na tretjem mestu je bila rast skupne faktorske produktivnosti. Treba je še omeniti, da je izbrana serija upoštevala širšo definicijo človeškega kapitala, ki vključuje k visoko izobraženim delavcem usmerjen tehnološki napredek. Če uporabimo indeks povprečnega števila let šolanja, ki tega tehnološkega napredka ne upošteva, se prispevek človeškega kapitala zmanjša na 0.3-odstotne točke, prispevek skupne faktorske produktivnosti pa se poveča na 1.6-odstotne točke.

Ugotavljamo tudi, da je zamenljivost med delom in kapitalom ter med nizko in visoko usposobljenimi delavci v Sloveniji v skladu z ugotovitvami mednarodnih raziskav. Tehnološki napredek, ki favorizira visoko usposobljene delavce, pa nekoliko zaostaja.

S pomočjo ocene obsega proizvodnih dejavnikov v prihodnje smo izdelali osnovno projekcijo rasti BDP na prebivalca za obdobje od 2002 do 2013. Rast zaposlenosti naj bi bila v Sloveniji v prihodnje še manjša kot v preteklosti, predvidevamo pa tudi upočasnitev ali celo prenehanje poglabljanja kapitala. Po drugi strani pričakujemo, da se bo okrepila rast človeškega kapitala Ob nekoliko nižji rasti skupne faktorske produktivnosti napovedujemo okrog 3.6-odstotno povprečno letno rast BDP na prebivalca v obdobju do leta 2013. Osnovna projekcija predvideva tudi višjo povprečno rast plač kot v predhodnem obdobju, manjšo rast plač visoko usposobljenih delavcev glede na delavce z nižjo izobrazbo ter v povprečju znižanje deleža investicij v skupni proizvodnji.

V nadaljevanju predstavljamo analizo občutljivosti osnovne projekcije na spremembe v posameznih dejavnikih. Glede na gibanja v preteklem obdobju smo ugotovili, da je osnovna projekcija najbolj občutljiva na preteklo rast kapitala. Če uporabimo alternativno serijo za človeški kapital (nižja rast človeškega kapitala v preteklosti), je njen vpliv na nadaljnjo rast bruto domačega proizvoda v veliki meri nevtraliziran z nasprotno spremembo v predvideni rasti skupne faktorske produktivnosti. Kar zadeva bodoča gibanja se, ob razumnem intervalu možne rasti proizvodnih dejavnikov, predvidena stopnja gospodarske rasti giblje med 3.1% in 4.0%. To je v skladu z ugotovitvami tudi drugih študij, ki se ukvarjajo s projekcijami za Slovenijo in večinoma napovedujejo gospodarsko rast med 3% in 4%.

Prispevek zaključujemo z analizo približevanja Slovenije povprečni ravni BDP na prebivalca v EU. Z ekstrapolacijo stopenj rasti v EU-15 v zadnjih tridesetih letih in ob predpostavki, da bo letna rast v desetih pridruženih članicah 3.6%, smo prišli do predvidene 2.3-odstotne povprečne letne realne stopnje rasti v EU v obdobju od 2002 do 2013. Slovenija je v letu 2002 dosegla približno 76% povprečne ravni BDP na prebivalca v EU. Da bi Slovenija dohitela EU do leta 2013, bi se moral njen BDP na prebivalca v obdobju od 2002 do 2013 v povprečju letno realno povečati za 4.9% oz. za 1.3-odstotne točke več, kot je predvideno v osnovni projekciji.

Naj sklenemo z opozorilom, da zgornja analiza temelji na kratkih časovnih serijah in to za gospodarstvo, ki je bilo v zadnjem desetletju priča precejšnjim strukturnim spremembam, te spremembe pa se bodo nadaljevale tudi še v prihodnje. Naše ugotovitve za preteklo obdobje in projekcije za prihodnost je zato treba interpretirati bolj previdno, kot je to običajno.

Ključne besede: fizični kapital, človeški kapital, računovodstvo gospodarske rasti, skupna faktorska produktivnost, projekcija, konvergenca

Summary

Following a strong contraction, GDP per capita has grown at a brisk pace since the early 1990s in Slovenia. Over the period 1993-2002 the average annual growth rate was 4.1%. To determine the main driving forces behind this high growth rate we construct series for physical and human capital. Our preferred series for physical capital grows at an annual rate of 6.8% over the period 1993-2002, suggesting substantial capital deepening. Our preferred series for human capital grew at an annual rate of 1.6% over the same period, where human capital is broadly defined so as to include skill biased technological change.

Using our constructed series for physical and human capital, and data on employment and output growth, we then use growth accounting to determine the contributions of these inputs to output growth over the period 1993-2002, and the growth in the residual or 'total factor productivity' (TFP). Using our preferred series we find that (on average) employment, human capital, physical capital and TFP accounted for 0.1, 1.1, 2.0 and 0.8 percentage points of output growth. The contribution by employment is low because there was almost no growth in labor input over the relevant period. Human capital grew not as fast as physical capital, but human capital gets a higher weight in output growth. As a result, human capital growth comes in second after physical capital growth in the growth decomposition. TFP is third after human capital growth. However, our preferred series of human capital includes skill biased technological change. When we use an index of average years of schooling instead, which excludes skill biased technological change, the contribution by human capital drops to 0.3 and the contribution by TFP rises to 1.6 percentage points.

In the process we further find that we do not reject that the substitutability between labor and capital, and between low- and high-skilled workers in Slovenia, is in line with international findings. Skill biased technological change seems to be a bit lower.

Using an educated guess for the inputs in the future, we make a base projection for the growth in GDP per capita over the period 2002-2013. Employment growth is expected to be even lower than in the past, and we project a slowdown and eventual end to capital-deepening in Slovenia. However, the growth in human capital is expected to pick up. Combined with a slightly lower growth in TFP in the future we project an average annual growth in GDP per capita of about 3.6% over the period 2013. The base projection further has higher average wage growth than in the previous period, a fall in the wage of high- relative to low-skilled workers and (on average) a slight drop in the investment-output ratio.

Next, we present a sensitivity analysis of the base projection. Regarding developments in the past, we find that the base projection is the most sensitive to past capital growth. The impact of an alternative series for past human capital growth on future growth is to a large extent offset by an opposing change in projected TFP growth. Regarding future developments, for reasonable lower and upper margins for the growth in the inputs the projected growth rate stays in a band of 3.1% to 4.0%. This is in line with the findings of (most) other studies that make a projection for Slovenia. Their projections range from 3% to 4%.

We conclude with an analysis of convergence to the EU average in terms of GDP per capita. Using an extrapolation of growth rates in the EU-15 over the past 30 years and assuming that the 10 new member states will grow at an annual rate of 3.6%, we come to a projected average growth rate of 2.3% for the EU over the period 2002-2013. In 2002 Slovenia was at about 76% of average GDP per capita in the EU. To catch up with the EU by 2013, real GDP per capita in Slovenia would then have to grow at an annual rate of 4.9% over the period 2002-2013, or 1.3% faster than in the base projection.

Finally, we conclude with a cautionary note. The preceding analysis builds on short data series of an economy that has witnessed substantial structural changes over the past decade, and can be expected to witness more of them in the future. Hence, our findings from the past and projections for the future should be interpreted with perhaps more than the usual care.

Keywords: physical capital, human capital, growth accounting, total factor productivity, projection, convergence

1. Introduction[1]

Over the period 1993-2002 average annual growth in the gross domestic product (GDP) per capita in Slovenia was 4.1 percent. What were the determinants of this rapid growth? Furthermore, can we expect these growth rates to continue in the future? And will this be enough for Slovenia to catch up with the EU in terms of GDP per capita in the foreseeable future? This paper tries to give some preliminary answers to these questions. The outline is as follows.

In Section 2 we first consider the growth in GDP, employment, human capital and physical capital in the past. Following Section 2 is a brief *intermezzo* where we consider the substitutability between labour and capital. Section 3 then uses the series of Section 2 for some growth accounting exercises to quantify the role played by these inputs and (the residual) total factor productivity (TFP) in past GDP growth. In Section 4 we turn to the future, where we make a base projection for future output given an educated guess for future inputs. Section 5 presents a sensitivity analysis of this projection. Section 6 then considers convergence with the EU in terms of GDP per capita. Section 7 concludes.

[1] CPB Netherlands Bureau for Economic Policy Analysis (CPB) and Institute for Economic Research (IER). Address: CPB Netherlands Bureau for Economic Policy Analysis, Van Stolkweg 14, P.O. Box 80510, 2508 GM The Hague, The Netherlands. Phone +31-70-3383380, fax +31-70-3383350, e-mail: jongen@cpb.nl. I am grateful to Peter Broer, Nick Draper, Ivo Lavrač, Arjan Lejour, Boris Majcen, Janez Šušteršič, Miroslav Verbic and especially Janez Kušar for comments and suggestions. I thank Marjan Hafner, Saša Kovačič, Tomaž Kraigher, Janez Kušar and Ivanka Zakotnik at IMAD for data. Furthermore, I thank Louis Kuijs (IMF) and Slaven Mičkovič (Slovenian Ministry of Finance) for sending me their capital series for Slovenia, and Arjan Lejour (CPB) for sending me the future scenarios for Europe of the WorldScan model. Finally, I thank Dale Jorgenson for some references. Any remaining errors are my own. Furthermore, opinions or views expressed in this paper are my own and do not necessarily coincide with the opinions or views of CPB, IER or IMAD. All data, constructed series and graphs can be found online at: www.gov.si/umar. This paper serves as a background paper for the new strategy for the government to be implemented in 2006. For a preliminary draft of the new strategy, see: www.gov.si/umar. For past strategies, see Potočnik *et al.* (1995, 1998).

2. Growth in GDP and inputs in the past

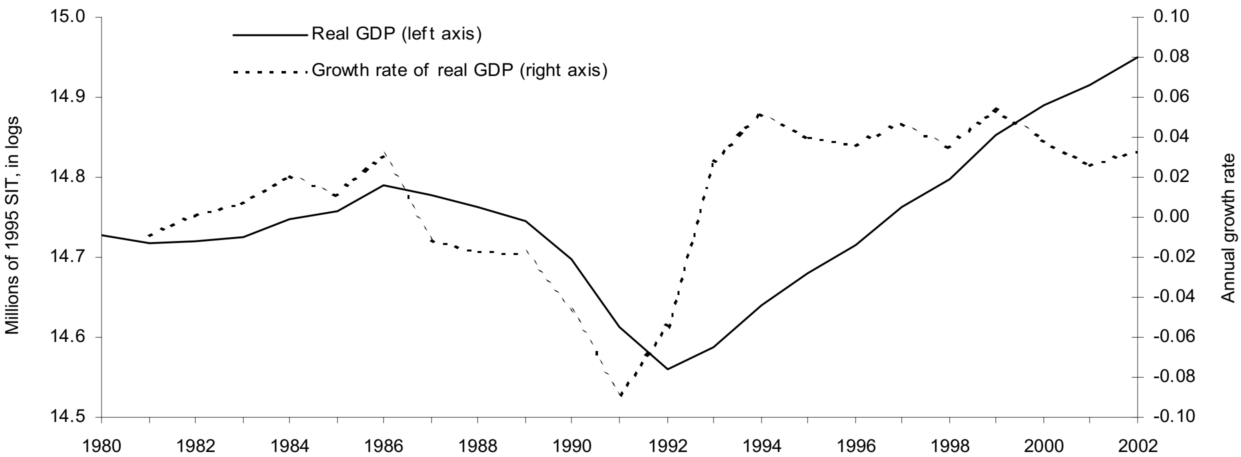
Below we consider past developments in GDP, labour, human capital and physical capital. In the formal analysis below we only consider the period 1993-2002.[2] We restrict the formal analysis to the period after 1992, in part because some series from before are not readily available and/or comparable (due to *e.g.* changes in methodology), but also because they may be of limited use when we believe they are taken from an economy that has witnessed substantial structural change later on.[3] Still, in the informal discussion of the past growth in output and inputs, to add some perspective we do consider some data from the period before 1993. We start with a look at past GDP growth.

2.1. GDP

The rapid growth in GDP over the period 1993-2002 was preceded by a strong contraction over the period 1987-1992

Figure 1 gives the development of GDP over the period 1980-2002.[4] The solid line gives (the log of) real output, and the dotted line gives its growth rate. As in most socialist countries, output started to decline by the end of the 1980s/early 1990s.[5] In Slovenia, output started to decline in 1987. The decline accelerated in the period 1989-1991, 1992 still witnessed a strong contraction, and 1993 marked the beginning of the subsequent high growth period.[6] Although the later growth rates were more or less spectacular, it would still take up to 1998 before real GDP surpassed the

Figure 1: **Gross Domestic Product**



Source: Own calculations using data from the Statistical Office of the Republic of Slovenia (SORS) and IMAD. **Note**: For 1980-89 we use the growth rate of the so-called (real) 'gross social product' to calculate GDP backwards, using internal data of IMAD. For 1990-1994 we also use internal data of IMAD, but now for real GDP growth. For 1995-2002 we use the latest data on real GDP growth from the SORS.

[2] The notable exception is the investment series from before 1993, which are used to obtain an educated guess for the capital stock in 1993.

[3] As the saying goes 'you never step in the same river twice', but here we might be stepping into a different river altogether.

[4] For the years 1980-1989 we use the growth rate in the so-called 'gross social product' (GSP) to calculate GDP backwards starting from 1990. The GSP was the socialist counterpart to GDP in Yugoslavia, one of the main differences being that part of the services included in the definition of GDP were not included in the GSP. Piatkowski (2003) suggests that the growth in the GSP is not a bad proxy for the growth in GDP, partly because the services sector may have been held back during the socialist times.

[5] Section 6 below considers some data for other (former) socialist countries.

[6] In 2001 and 2002 growth slowed down, perhaps mostly due to business cycle factors like a downturn of foreign demand.

level of 1986. Indeed, the cumulated contraction of real GDP was a massive 20 percent by 1992.

In the analysis below we are interested in the determinants of the high growth rates over the period 1993-2002, but here we take a brief detour to consider what caused the contraction in output before then. A detailed analysis is beyond the scope of this paper though, the reader is referred to Campos and Coricelli (2002) and Roland (2000) for an analysis of the decline in output in transition economies in general, and Buehrer (1994) and Gligorov (2004) for Slovenia in particular.

The following factors seem to have played a role in the output decline in Slovenia. First, there is the transition from a socialist to a market economy, where frictions caused a 'transformational recession' (Kornai, 1993) as production units were reallocated from old to new production sites. We may think of these frictions as being broadly defined so that it includes credit constraints, the 'disorganisation' of production chains *etc.* (see Roland, 2000, for an overview). However, within the group of socialist regions/countries Slovenia was perhaps already the most oriented to the West (in terms of the share of market transactions and trade with Western European economies). This may have limited the 'transformational recession' in Slovenia. Second, the synchronisation in the decline in output in Central and Eastern European Countries (CEECs) was probably not very helpful either, as trade amongst these countries declined. Third, the global economic downturn associated with the (first) Gulf War limited the growth of trade with Western countries. With a large part of its trade already oriented to the West, this may have hit Slovenia relatively hard. Finally, and perhaps most importantly, the declaration of independence and the war in the other republics of Yugoslavia led to a dramatic drop in trade with these republics.[7] According to Buehrer (1994, p.2) '[P]rior to 1991 trade with the rest of Yugoslavia accounted for 25% of all sales of goods in Slovenia. Since then trade with the rest of Yugoslavia has fallen by over 80%.' The decline in demand from other Yugoslav markets put additional pressure on the Slovenian economy to restructure its production processes. From this brief detour we take that on the one hand Slovenia had a head start as far as the transformation to a market economy was concerned. However, on the other hand, the loss of the markets of the other republics of former Yugoslavia still caused a very deep contraction of the Slovenian economy. We consider the factors of the subsequent upswing below.

2.2. Employment

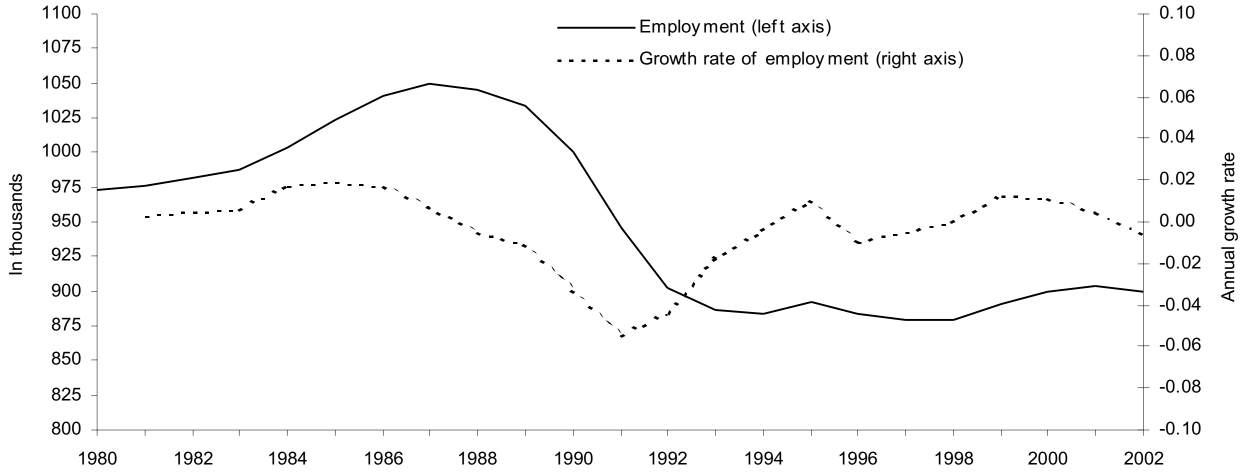
Over the period 1987-1992 the drop in employment was less severe than the drop in output.

Figure 2 shows the development of employment in full-time equivalents (FTEs).[8] Like the GDP series above, the employment series shows a dramatic decline in the late 1980s/early 1990s. However, a comparison of Figure 2 with Figure 1 reveals that the drop in employment was not as severe as the drop in GDP. Indeed, the cumulated drop in employment was 13% over the period 1986-1992, compared to a cumulated drop of 20% in GDP.

[7] Using a computable general equilibrium model for Slovenia, Buehrer (1994) computes that about two-thirds of the decline in output can be attributed to trade losses.

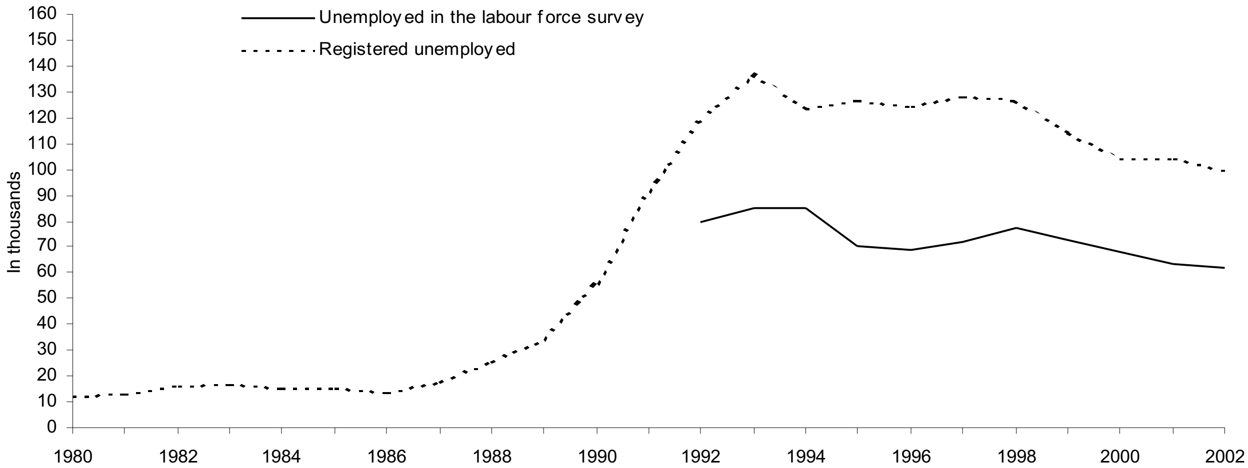
[8] There is a break in the series in 2000 due to a change in methodology. We use the growth rates for the 1992-2000 period and the stock in 2000 according to the old and new methodology to approximate employment in 1992-1999 according to the new methodology. Further, for before 1992 we use the growth rate of employment in the national accounts to calculate the employment in full-time equivalents backwards (internal sources at IMAD).

Figure 2: **Employment**



Source: Internal data of IMAD.

Figure 3: **Unemployment**



Source: SORS (2003).

Over the period 1993-2002 employment growth was negligible.

Figure 2 further shows that, since 1992, growth in employment has been negligible. Hence, employment growth cannot have been one of the main driving forces in output growth since then. Furthermore, employment has never recovered to its pre-transition levels.[9] In 1980 employment was about 975,000 FTEs, in 2002 it was about 900,000 FTEs. We cannot explain this drop by the change in the population, which increased in the same period from 1.9 million to around 2.0 million. Part of the answer can be found in the rise in unemployment, see Figure 3. During socialist times, unemployment was kept (presumably artificially) low. Over the period 1986-1993 the number of registered unemployed rose from 14,000 to 140,000 individuals. Since 1993, unemployment has been trending downward, interrupted briefly by a temporary rise around 1998. Figure 3 further shows that the rise in unemployment was less dramatic when we use the ILO definition of unemployment used in the Labour Force Survey (LFS, those actively seeking a job, readily available *etc.*). By 2002 the unemployment rate in Slovenia had fallen

[9] Presuming that the data on past employment levels in FTE are not too far off, see also Footnote 8.

to 6%. This is not particularly high in a market economy. For comparison, the EU-15 and EU-25 had average unemployment rates of 8% and 9% in 2002, respectively. Furthermore, the rise in unemployment can only explain part of the drop in employment, gross participation also fell.

2.3. Human capital

Another determinant of output growth is the growth in the skills of employees. Below we consider three different indicators for the average skill level of employees: i) average years of schooling; ii) average wages relative to the unskilled; and iii) a CES-composite of the skills of low- and high-skilled workers. We first consider these indicators separately, then discuss how developments in these indicators compare to each other, and end with a brief discussion of the pros and cons of one indicator compared to another.

2.3.1. Average years of schooling

Over the 1993-2002 period the average number of years of schooling increased from 11.0 to 11.6 years.[10] This implies an average absolute change of 0.07 years of schooling per annum, or an annual increase of 0.5 percent. For comparison, over the 1990-1998 period the average number of years of schooling in the EU-15 increased from 10.0 to 10.8 years.[11] This implies an average annual absolute change of 0.1, or an annual increase of 1 percent. Hence, considering the growth in the average years of schooling Slovenia did worse than the average of the EU-15.

The increase in average years of schooling during the 1990s was lower in Slovenia than in the EU-15.

How do we get from average years of schooling to the impact on output? For this we use the transformation of Hall and Jones (1999). The average skill index of a worker at time *t*, *H(t)*, is given by

$$H(t) = e^{\theta(s(t))},$$

where $\theta(\,.\,)$ is a piece-wise linear function of the average years of schooling *s(t)* at time *t*. Motivated by micro-level studies on the returns to education Hall and Jones (1999) come to the following specification for $\theta(\,.\,)$.[12] For *s(t)* smaller or equal to 4 years $\theta(\,.\,)$ = 0.134 *s(t)*, for *s(t)* in between 4 and 8 years $\theta(\,.\,)$ = 0.134*4 + 0.101 (s(t) - 4), and for *s(t)* bigger than 8 years $\theta(\,.\,)$ = 0.134*4 + 0.101*4 + 0.068 (s(t) - 8). Hence, although more years of schooling make an individual more productive, the returns to additional years of schooling fall with the years of schooling already accumulated. Using this transformation, we find that the average annual growth in the human capital index over the period 1993-2002 was 0.4%.[13]

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[10] Source: IMAD.

[11] Source: Own calculations using data reported in Table 2.1 in OECD (2003).

[12] See Psacharopoulos (1995) for an excellent introduction to the literature on returns to education.

[13] Note that the growth in the average years of schooling may understate the actual growth in the human capital index when we believe that part of the skills acquired during the socialist time became obsolete during the transition, leaving a lower effective initial stock of human capital.

2.3.2. Average wages relative to the wages of the least skilled

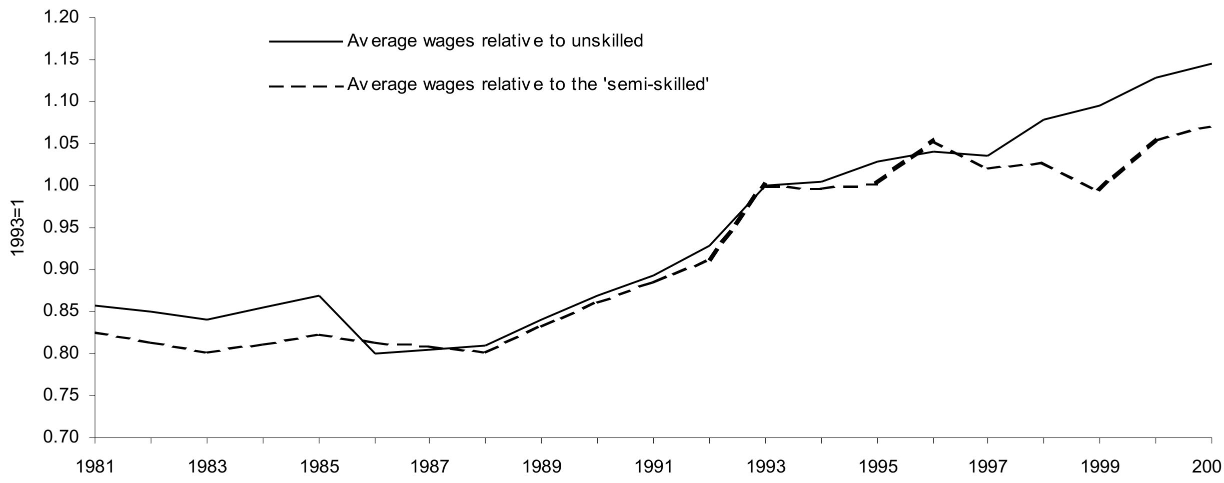
The growth in wages relative to the least skilled was higher than in average years of schooling

Another measure for the average skills of employees is average wages of all employees relative to the wages of the least skilled. The human capital of the unskilled is supposed to remain unchanged over time. Furthermore, note that by taking the wage relative to the unskilled we further control for changes in total factor productivity and the capital-labour ratio.[14] Figure 4 gives two indices for the average human capital of employees, one using average wages relative to wages of the unskilled and one using average wages relative to wages of the 'semi-skilled' (the next lowest skill group in the classification of the SORS).[15] We also consider average wages relative to the 'semi-skilled' as the unskilled, for example, may not benefit from labour augmenting technological change at all. Both indices are normalised to 1 in 1993.

For the period up to 1997 both series show a more or less similar pattern. Interestingly, wages of the average worker relative to the least skilled appear to fall up to the late 1980s. Although it is hard to believe that the average level of human capital per worker actually fell during this period, it does suggest that the increase in human capital over this period was perhaps limited and/or was not rewarded with higher wages.

From the late 1980s onwards, average wages relative to the least skilled start to rise. This may reflect a rise in human capital. However, this may also reflect a reduction in wage compression following socialist times. Further, it may reflect that individuals with lower skills were hit more severely by the output contraction, for example because they were over-represented in production that was oriented to former Yugoslavia or other transition countries. In any case, the annual growth rate of the average wage relative to the unskilled and 'semi-skilled' was substantial over the 1989-1993 period, 4.4% and 4.7%, respectively.

Figure 4: **Average wages relative to the wages of the least skilled**



Source: Own calculations using data from SORS (2003).

[14] Assuming, perhaps erroneously, that there is no capital-skill complementarity. See *e.g.* Krusell *et al.* (2000) for a recent study on capital-skill complementarity.

[15] Source: SORS (2003).

In the formal analysis below we are interested in the period from 1993 onwards. The data on average wages relative to wages of the least skilled are available up to 2001. Relative to the 1989-1993 period, the growth in average wages relative to the least skilled slows down, to 1.5% per year if we take the unskilled as the base, and to 0.8% if we take the 'semi-skilled' as the base.[16]

2.3.3. CES-composite of low- and high-skilled workers

Finally, we consider an index of average human capital where we allow for imperfect substitutability between skill types. For simplicity we divide workers into two groups: low- and high-skilled workers. High-skilled workers are individuals with tertiary education (international standard classification of education (ISCED) levels 5 and 6, *i.e.* individuals who have finished higher vocational training or have obtained a university degree). Low-skilled workers are individuals without a tertiary education.

The growth in the CES-weighted average of low- and high-skilled workers was also higher than average years of schooling

Effective labour in production at time t, $N^e(t)$, is given by the following CES (constant-elasticity-of-substitution) function

$$N^e(t) = \left(\alpha(A_H(t)N_H(t))^\sigma + (1-\alpha)(A_L(t)N_L(t))^\sigma\right)^{\frac{1}{\sigma}},$$

where α denotes a distribution parameter, $A_H(t)$ and $A_L(t)$ denote high- and low-skilled workers augmenting technological change at time t, $N_H(t)$ and $N_L(t)$ denote the number of high- and low-skilled workers at time t, and σ determines the (constant) elasticity of substitution between low- and high-skilled workers. $\rho \equiv 1/(\sigma-1)$. When $\sigma \uparrow 1$ then $\rho \to -\infty$, the two skill-types are perfect substitutes. When $\sigma = 0$ then $\rho = -1$, the Cobb-Douglas case. When $\sigma < 0$ then $\rho > -1$, and the two skill types are said to be complements. In the limit $\sigma \to -\infty$ and $\rho \to 0$, low- and high-skilled labour are 'perfect' complements.

Using the fact that the expression for effective labour has constant returns to scale, we may divide this expression through by total employment $N(t) \equiv N_L(t) + N_H(t)$ multiplied with low-skilled labour augmenting technological change $A_L(t)$ to obtain a more convenient expression consisting of 'raw' labour, low-skilled labour augmenting technological change and a 'human capital' index[17]

$$N^e(t) = \left(\alpha(A'_H(t)s_H(t))^\sigma + (1-\alpha)(s_L(t))^\sigma\right)^{\frac{1}{\sigma}} A_L(t)N(t),$$

where $A'_H(t)$ now denotes skill-biased technological change, $A'_H(t) \equiv A_H(t) / A_L(t)$, and $s_H(t)$ and $s_L(t)$ denote the shares of high- and low-skilled labour in employment, respectively.

Denote the labour costs of low- and high-skilled workers at time t by $w_L(t)$ and $w_H(t)$, respectively. Cost minimisation then implies the following relation between the demand for low- and high-skilled labour and their relative labour costs[18]

[16] Furthermore, since we are supposing that the growth in relative wages reflects the growth in relative productivity's we need not apply any transformation.

[17] The human capital index so defined includes skill-biased technological change.

[18] All derivations are available from the author on request.

$$\log(w_H(t)/w_L(t)) = \log(\alpha/(1-\alpha)) + \sigma\log(A'_H(t)) + (\sigma-1)\log(s_H(t)/s_L(t)).$$

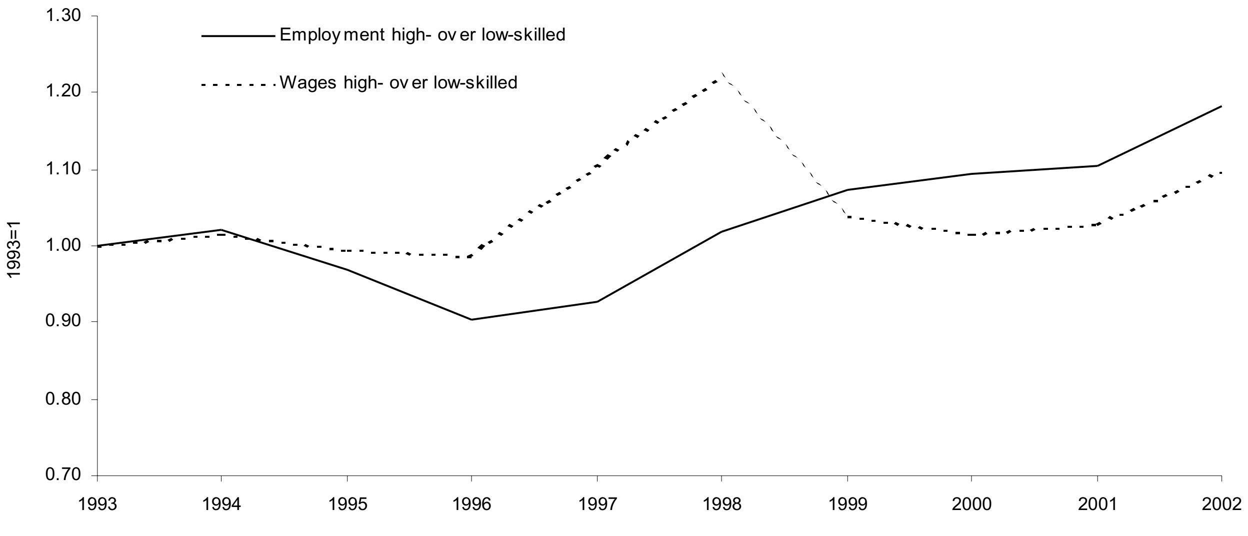
Assuming that $A'_H(t)$ is of the form $A'_H(0)(1+g)^t$, where $A'_H(0)$ denotes the initial level of the skill bias in technological change and g denotes its annual growth rate[19], and assuming that g is sufficiently small so that we can use the approximation $\log(1+g) \approx g$, we can rewrite the above expression into the estimating equation

$$\log(w_H(t)/w_L(t)) = c + \sigma g t + (\sigma-1)\log(s_H(t)/s_L(t)) + \varepsilon_t,$$

where $c \equiv \log(\alpha A'_H(0)^\sigma/(1-\alpha))$ and ε_t denotes a (independently and identically distributed) disturbance term. By using data on relative wages and relative employment shares we can estimate the parameters of interest.

In Figure 5 we first consider the data to be used in the estimation.[20] We observe a rise in the relative supply of high-skilled workers, the index rises from 1 in 1993 to 1.18 in 2002 (the share of high-skilled workers rises from 16.0% in 1993 to 18.4% in 2002). However, despite the rise in the relative supply of high-skilled workers their relative wages also increased, from 1 in 1993 to 1.1 in 2002.[21, 22] This suggests we have skill-biased technological change.[23] An informative period for the substitutability between the two types of labour further seems to be the

Figure 5: **Wages and employment of low- and high-skilled**



Source: Internal data of IMAD.

[19] A higher order term for the time trend was not supported by the data.

[20] Source: Own calculations using SORS data on wages for workers with different skill types and the number of workers per skill type.

[21] For a similar finding for the U.S., see *e.g.* Acemoglu (2002a).

[22] We will use relative gross wages as a proxy for relative labour costs in the estimations. One imperfection with this proxy is that we do not take into account the 'payroll tax' introduced in the mid 1990s. The payroll tax is progressive and was not fully indexed to the growth in average gross wages.

[23] Or that the human capital of high-skilled workers increased more than the human capital of low-skilled workers (in percentage terms) over this period. Again, another possibility is that high-skilled workers are closer substitutes to capital than low-skilled workers. However, given the sparse information on the capital stock in Slovenia over the relevant period we do not consider this possibility here. We note though that the rise in relative wages of high-skilled workers is consistent with the rise in the capital-output ratio in our constructed capital series (see below) combined with capital-skill complementarity.

Table 1: **Substitutability between low- and high-skilled labor**

Estimated parameter	σg	σ-1	R^2	Durbin-Watson
Using $s_H(t)/s_L(t)$	0.011 (0.011)	-0.148 (0.402)	0.14	1.70
Using $s_H(t-1)/s_L(t-1)$				
unrestricted	0.020 (0.008)	-0.871 (0.310)	0.60	2.13
σ -1 = -.660	0.017 (0.006)	-0.660 -	0.57	2.16

Note: Standard errors in parentheses; estimation period: 1993-2002.

period 1998-2000, where we witness a steep decline in the relative wages of high-skilled workers following a steep rise in the relative supply of high-skilled workers.[24]

The estimation results using these data are given in Table 1. For comparison, reviewing the literature on the demand for low- and high-skilled labour Katz and Autor (1999) suggest that the elasticity of substitution between low- and high-skilled labour ρ is around -1.5, or σ is around 0.33, and the annual rate of skill-biased technological change is around 3%.[25]

When we estimate the contemporary relation between the relative wages and the relative supply of high-skilled workers we find a value of σ = 0.85, which would imply a substitution elasticity of about -6.7. Compared to the studies reviewed by Katz and Autor (1999), this would be a relatively high substitutability between low- and high-skilled labour. Furthermore, we find an annual rate of skill-biased technological change σg of about 1%, which seems relatively low. Before we draw any conclusions from this, we note that the role of both factors is measured relatively imprecisely. Indeed, only 14 percent of the deviation from the mean is 'explained' in the estimation.[26]

Using one period lagged rather than the contemporary relative supply of high-skilled workers greatly improved the 'explanatory' power of the estimating equation (a casual look at Figure 5 suggests that perhaps wages respond to the relative supply with a delay). Using the one period lagged value of the relative supply of high-skilled workers suggests a value $\sigma = 0.13$, which would imply a substitutability between low- and high-skilled labour in production that is somewhat lower than suggested by Katz and Autor (1999), although it clearly does not differ significantly from the value suggested by Katz and Autor (1999). Note, however that in this case we do reject the null-hypothesis that low- and high-skilled labour are perfect substitutes (σ=1) at the 95-percent confidence level. We further find an annual rate of skill-biased technological change of 2.0% per year.

The rate of skill-biased technological change we find for Slovenia is a bit lower than in studies on other developed countries

[24] I first calculated the average wage for individuals with a tertiary education and then calculated the average wage of the low-skilled as a residual using data on average wages for all workers and the shares of low- and high-skilled workers in employment. However, the sudden rise and drop in the relative wages of the high-skilled around 1998 is not an artefact of the construction method. The relative wages of individuals with a university degree (and to a lesser extent the relative wages of individuals with higher vocational training) show a similar pattern around 1998, see Table 13.5 in SORS (2003).

[25] Clearly, there may be some difficulties in making international comparisons due to differences in the quality and classifications of education types across countries.

[26] As an experiment I introduced a dummy for the year 1998, which seems to be an 'outlier'. However, collinearity between the regressors then becomes a (more) serious problem resulting in very imprecise coefficient estimates. Indeed, we then remove the most informative data point in the series regarding the substitutability between the two skill types.

Finally, as another alternative, suppose that we fix the substitutability at the value suggested by Katz and Autor (1999) (which we do not reject in the unrestricted regression). We then find an annual rate of skill-biased technological change of 1.7% per year.

Concluding, we find that using lagged relative employment shares greatly improves the 'explanatory' power of the estimation. We do not reject that the substitutability of low- and high-skilled labour is in line with the international findings of Katz and Autor (1999), but the rate of skill-biased technological change seems to be somewhat lower in Slovenia.[27, 28]

We proceed by constructing a human capital index using the above mentioned regression results for the substitutability between low- and high-skilled labour with lagged employment shares. The (poor) estimation results using contemporary employment suggest a rise in the human capital index of 0.6% per year. The unrestricted estimation results using lagged employment suggest a rather dramatic rise in the human capital index of 4.6% per year. Finally, the 'middle-of-the-road' estimation with σ fixed at the 'international' value of 0.34 suggest an annual rise in the human capital index of 1.6% per year, which is our preferred estimation.

We close this section by noting that, although we refer to the index as a 'human capital' index, it is in fact a composite of human capital and skill-biased technological change. Still, we can argue that the index reflects the role of skills in final output. With less high-skilled workers one also misses out on the skill-biased technological change for these workers.

2.3.4. A comparison of the human capital indices

The human capital indicator 'CES-weighted average of low- and high-skilled workers' is preferred

In the sections above we considered the growth in 3 human capital indices over the period 1993-2002. Using (the Hall and Jones transformation of) average years of schooling as an indicator of average human capital we obtain an annual growth rate of human capital of only 0.4% over the period 1993-2002, somewhat below the annual average of the EU-15 over the period 1990-1998.

Using average wages relative to the least skilled suggests an annual growth rate of the human capital index between 0.8% (using 'semi-skilled' as a base) and 1.5% (using 'unskilled' as a base). Using a CES-weighted average of low- and high-skilled workers suggests an annual growth rate in the human capital index between 0.6% and 4.6%, with 1.6% in our preferred estimation.

Average years of schooling gives a lower growth in the human capital index than the other two indices because it does not include skill-biased technological change. Using average wages relative to the least skilled one implicitly incorporates skill-biased technological change in the human capital index. The CES-weighted human

[27] One explanation as to why skill-biased technological change is lower in Slovenia than in other countries on average could be the idea of 'directed technological change' of Acemoglu (2002b), where the invention and adoption of technologies is directed to factors that are relatively abundant. The relatively low share of Slovenians with a tertiary education (see Jongen, 2004a, for a comparison of Slovenia with the EU-15 countries on many variables) may have limited the bias of technological change towards high-skilled workers in Slovenia.

[28] One further issue is whether we are estimating a 'true' or a 'spurious' relation (Granger and Newbold, 1974). With only 10 observations, we cannot reject either hypothesis. On the one hand, we find that we cannot reject that both log relative wages and log lagged relative employment are integrated of the first order (have a unit root). However, on the other hand, we also cannot reject that they are cointegrated (they 'share the same random walk'). As we have no other data, we will assume that we are in fact estimating a 'true' relationship.

capital index of low- and high-skilled labour explicitly includes skill-biased technological change. Given the relatively large gap in the growth in the first and the latter two human capital indices, the role of human capital in past GDP growth in Slovenia basically depends on whether one defines human capital as including skill-biased technological change.

Which series are to be preferred? We prefer to use the CES-weighted series of low-and high-skilled labour. We prefer the CES-weighted series to the average years of schooling because it includes the interaction between technological change and the share of high-skilled workers and because it allows for imperfect substitutability between different worker types. By using average years of schooling, one implicitly assumes that workers are perfect substitutes, which we reject in Section 2.3.3. We also prefer the CES-weighted series to the average wages relative to the least-skilled wages series because the latter also assumes perfect substitutability between skill types. A drawback of the CES-weighted series vis-à-vis the average wages relative to the wages of the least-skilled series is that it does not take into account the full distribution of skill types. However, note that the average annual growth rate in the human capital index in the latter two indices are quantitatively similar (for the preferred estimation of the CES-weighted index).[29]

2.4. Physical capital

No official physical capital series for Slovenia exists.[30] Hence, below we construct our own series for the capital stock. We consider two methods: i) the perpetual inventory method using past real investment series; and ii) the implicit capital stock from the equalisation of the marginal product of capital to its user cost. We conclude with a brief comparison of these two series and the findings of other studies on the capital stock in Slovenia.

2.4.1. Capital series using the perpetual inventory method

In the perpetual inventory method we accumulate investments forward, starting with an initial guess for the capital stock and assuming a particular depreciation rate. Specifically, the capital in year *t*, *K(t)*, is supposed to be given by

$$K(t) = (1-\delta)K(t-1) + I(t),$$

[29] Another paper that constructs a human capital index series for Slovenia is Bovha Padilla and Padilla Mayer (2002) who try to construct a human capital index a la Collins and Bosworth (1996). Collins and Bosworth (1996) use rates of return combined with years of schooling required for a few education classes to calculate an average wage relative to the least skilled without taking into account skill-biased technological change. Bovha Padilla and Padilla Mayer (2002) use relative wages of skill types and average years of schooling per skill type to calculate rates of return. They then calculate what is in my opinion a faulty index. Indeed, if the point is to get to some average wage relative to the least skilled, one can readily take the wages they start with. I tried to construct a Collins and Bosworth (1996) index for human capital in Slovenia using the rates of return suggested by Bovha Padilla and Padilla Mayer (2002), and using the shares of the skill types and average years of schooling per type of education supplied by Tomaž Kraigher (IMAD) (details available on request). The result is an index that grows at an annual rate of 0.4% over the 1992-2000 period, compared to only 0.1% in the study of Bovha Padilla and Padilla Mayer (2002). For completeness, using the series for low- and high-skilled employment and wages of Section 2.3.3 I come to a Collins and Bosworth (1996) human capital index that grows at 0.6% annually over the 1993-2002 period.

[30] Slovenia is but one of many other countries without an official capital series. In Rapid Report No. 107 of the SORS published on the 29th of April 2002, the SORS reports preliminary estimates for the capital stock in 1999. Since then, there have been no updates on the official capital stock in Slovenia (personal communication with the SORS). The reported capital-output ratio of more than 3 times GDP seems relatively high however (intangible assets are only a small part, so this does not explain the relatively high figure, furthermore residential housing also appears to be largely excluded). For a similar conclusion about the official capital series in Hungary see Pula (2003).

where *I(t)* denotes gross real investment in year *t*, and δ denotes the depreciation rate of capital (typically assumed constant, but see below).

Using the perpetual inventory method, we find that the capital-output ratio declined over the period 1983-1994, and increased over the period 1995-2002.

We start with an initial guess for capital in the base year of 1972. From various statistical yearbooks of the SORS we can construct a value for GDP in 1972 in 1995 prices. We come to a GDP in 1972 of SIT 1,511 billion (in 1995 prices). Suppose that the capital-output ratio in 1972 was 2.14[31], we then obtain an initial stock of capital of SIT 3,326 billion in 1972 (in 1995 prices). Assuming a different capital-output ratio in 1972 only has a minor effect on the capital series for the period 1993-2002.

As gross investment we take gross fixed capital formation (GFCF) in current prices from the National Accounts, converted to real terms with the implicit deflator for gross fixed capital formation from the National Accounts for the period 1991-2002 and the producer price index for the period 1972-1990 (no implicit GFCF deflator was available), with the price for 1995 normalised to 1.

Regarding depreciation, for the years 1972-1986 and 1993-2002 we assume an annual depreciation rate of capital of 0.075. Data from the capital count of private companies in Slovenia, which covers most private-sector firms, suggest an average depreciation rate of 7.5% per annum over the 1995-2001 period. This is somewhat above the 'typical' value of 6% used for developed countries (see *e.g.* Caselli, 2003). This may be due to the fact that the capital count of private companies does not cover capital with a low depreciation rate (*e.g.* roads). However, we may expect a somewhat higher depreciation rate in Slovenia due to above average scrapping of obsolete capital units following the transition. Finally, we note that compared to other studies on the Slovenian capital stock, our depreciation rate is pretty conservative. Bovha Padilla and Padilla Mayer (2002), Doyle *et al.* (2001), Mićković and Vasle (2004) and Piatkowski (2003) use a depreciation rate of 10%, 8%, 10% and 7.5%, respectively.

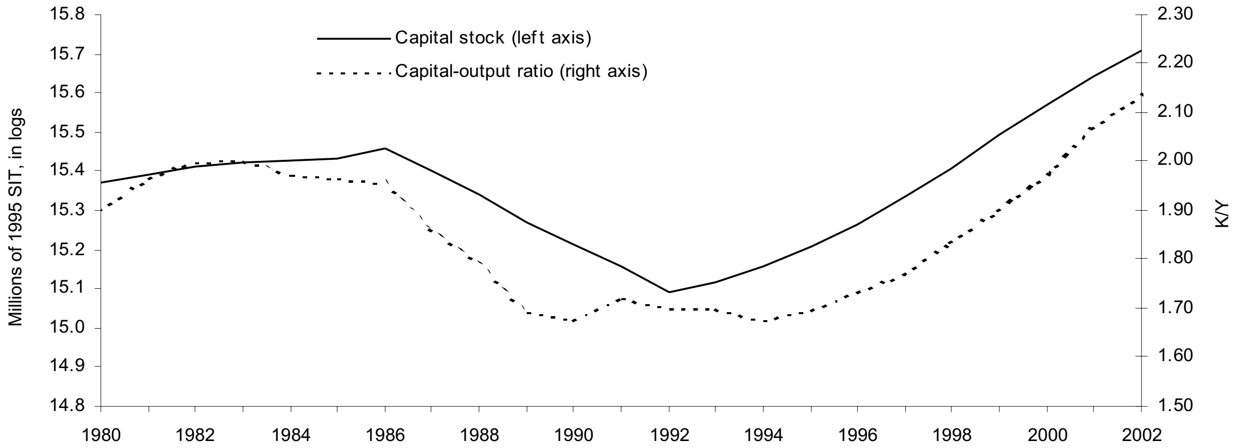
In the period 1987-1992 we assume double depreciation of the capital stock, *i.e.* 15% annually, due to intensified restructuring in the initial phase of the transition. Combined with the decline in real investment during this period, the cumulative drop in the capital stock is 32%. This decline is somewhat higher than the cumulated drop of 26% in the Slovenian capital stock calculated by Doyle *et al.* (2001) over the same period.[32]

Another way to deal with the impact of the contraction/transition period of 1987-1992 on the capital stock is to use growth accounting (following a lead from Pula, 2003). We consider growth accounting in more detail in Section 3 below. Growth accounting is normally used to calculate the growth in total factor productivity (TFP) as a residual, that is the growth in GDP not accounted for by the growth in (effective) labour and capital. Here, we use it to calculate the growth in capital as a residual, assuming a particular growth rate for TFP. Supposing that there was no growth in human capital in the period 1986-1993 (perhaps not unreasonable, consider for example the growth in average wages relative to the least skilled in Figure 4

[31] As the starting value for the capital-output ratio in 1972 we take the value we obtain in 2002, 2.14. We can motivate this by assuming that the capital-output ratio was as close to its balanced growth path in 1972 as it was 30 years later. For a starting value of 2.00, 2.14 and 2.28 in 1972 we obtain a capital-output ratio in 1993 (the first year for the formal analysis) of 1.69, 1.70 and 1.71 respectively. Hence, the exact starting value for 1972 is quantitatively not that important (due to depreciation of this initial stock over the subsequent 20 years before we get to 1993).

[32] Although a drop of 32% is dramatic, this may not be unrealistic. Indeed, Sinn and Sinn (1992) reported a drop of capital in East Germany of 50-75% after the reunification. However, East Germany was special in the sense that the government was striving for substantial wage equalisation between West and East Germany after the reunification.

Figure 6: **Capital stock and capital-output ratio**



Source: Own calculations using data from SORS and IMAD. **Note**: See the main text for the construction method.

above), no change in total factor productivity (due to the disruption of the workings of the economy), and taking the employment series given above, we come to a cumulated drop in the capital stock of 43% when we use the actual labour and capital income share for their respective output elasticity's and 39% when we use a constant output elasticity of labour and capital of 0.7 and 0.3, respectively (more on this below). This cumulative drop in capital is quite a bit larger than when we use double depreciation. However, the growth accounting exercise depends crucially on our assumption regarding TFP growth. For example, one can easily imagine a drop in TFP in these years. An annual drop in TFP of 0.5% during the period 1987-1992 would suffice to come to the cumulated drop of 32% in the capital stock we obtained when using double depreciation.

The resulting capital stock series, using double depreciation, is given in Figure 6. After an increase in the capital stock until the mid-1980s we observe a steep drop from 1987 to 1992 (due to higher depreciation and lower investment). From 1993 on, capital starts to grow relatively fast again. Over the period 1993-2002 we find an annual growth in the real capital stock of 6.8%. Still, it takes until 1999 for the capital stock to exceed the level of 1986 in real terms. Figure 6 also gives the corresponding capital-output ratio. The capital-output ratio shows a similar pattern as the capital stock, suggesting that the swings in the capital stock were bigger than the swings in output. Over the period 1993-2002 the capital-output ratio rises from 1.70 to 2.14, suggesting substantial capital deepening over this period.

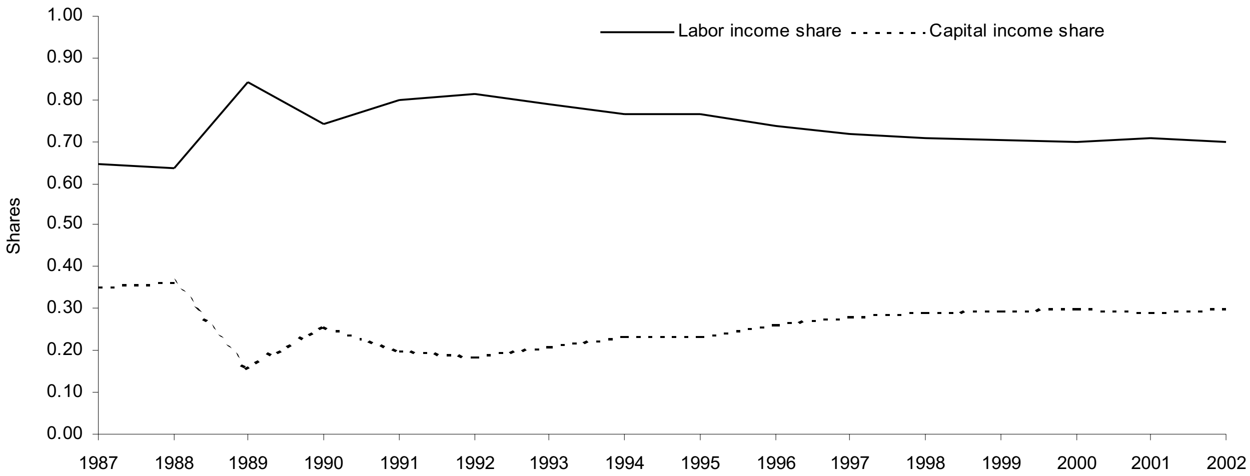
2.4.2. Capital series using the optimality condition

As an alternative, we can derive a series for the capital stock from the optimality condition that the marginal product of capital equals its user cost, following a lead from Mrkaic (2002).[33] Suppose that output is given by a Cobb-Douglas production function of labour and capital (which we do not reject, see the *intermezzo* below[34]). Furthermore, assume that the marginal product of capital equals the user cost of

[33] Mrkaic (2002) uses the marginal productivity condition only to calculate an initial capital stock, and then uses the capital accumulation equation of the previous section to calculate capital growth. Here we use the marginal productivity condition for the whole period.

[34] Furthermore, we obtain this result from the labour demand equation where we do not use our capital series. All we demand from capital in the estimation of the labour demand equation is that capital is paid its marginal product and that the production function has constant returns to scale.

Figure 7: **Labour and capital income share**



Source: Own calculations using National Accounts data from various issues of the Statistical Yearbook of the SORS. **Note**: The labour income share is calculated as the compensation of employees x (self-employed + employees)/employees / (GDP – (indirect taxes – subsidies)). The capital income share is the complement of the labour income share.

The optimality condition for capital suggests a much higher growth rate of the capital-output ratio, but this seems unrealistic

capital. The capital-output ratio then equals the capital income share over the user cost of capital.[35]

Figure 7 plots the labour and capital income share. The labour income share is defined as the total remuneration of labour (including imputed labour costs for self-employed, self-employed are not machines[36]), over gross domestic product minus indirect taxes plus subsidies. The capital income share is the complement of the labour income share. The series show a substantial drop in the capital income share in the late 1980s, and a subsequent recovery. Over the period 1992-1999 the capital income share rises from 0.19 to 0.30. Since 1999 the capital income share hovers around 0.30, a level comparable with the long-run level in many OECD countries. Below we compute capital series using these capital income shares. However, in Jongen (2004b) we argue that the drop in the capital income share would require an unrealistic change in the capital-output ratio and/or an unrealistic substitution elasticity between labour and capital. Therefore, we also consider the case that the capital income share is a bad proxy for the elasticity of output with respect to capital over the period 1993-2002 (capital was not paid its marginal product), and use a constant value of 0.3 instead.

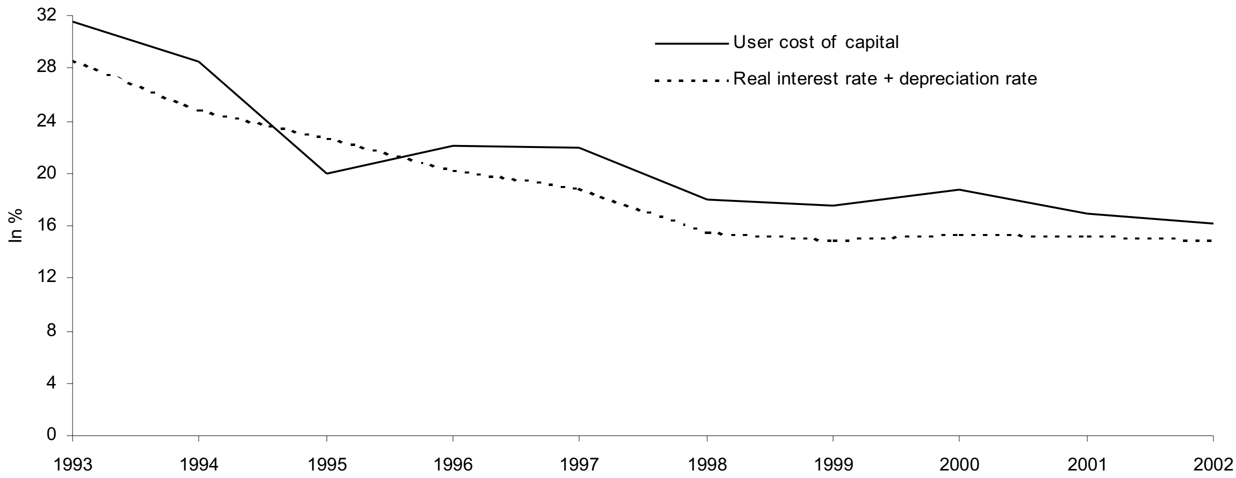
The other variable of interest is the user cost of capital. Unfortunately, the user cost of capital is not directly observed in the market. However, parts of its determinants are. We use these to construct the so-called Jorgensen cost of capital, $p_k(t)$. Consider the following intuitive derivation of the user cost of capital (see *e.g.* Jorgenson and Stiroh, 2000). Suppose we have an investor that is indifferent between two investment opportunities: 1) purchasing a unit of capital which depreciates at rate δ and then having the option of selling this piece of capital in the next period; or 2) investing in an alternative which earns him or her a nominal return of $r(t)$. For the investor to be indifferent we need to have[37]

[35] For the more general CES production function, the optimal capital-income share is a function of the substitution elasticity as well.

[36] We use SORS data on the number of self-employed relative to employment in full-time equivalents to inflate the labour income share to include the self-employed, assuming that all self-employed work full-time.

[37] Typically, the price of capital would also include taxes and subsidies related to capital accumulation. For example, an investment subsidy would lower the user cost of capital, whereas taxes on land (which we also count as capital) would raise the price of capital, *ceteris paribus*. We ignore these subsidies and taxes in our analysis.

Figure 8: **User cost of capital**



Source: Own calculations using SORS and Bank of Slovenia data.

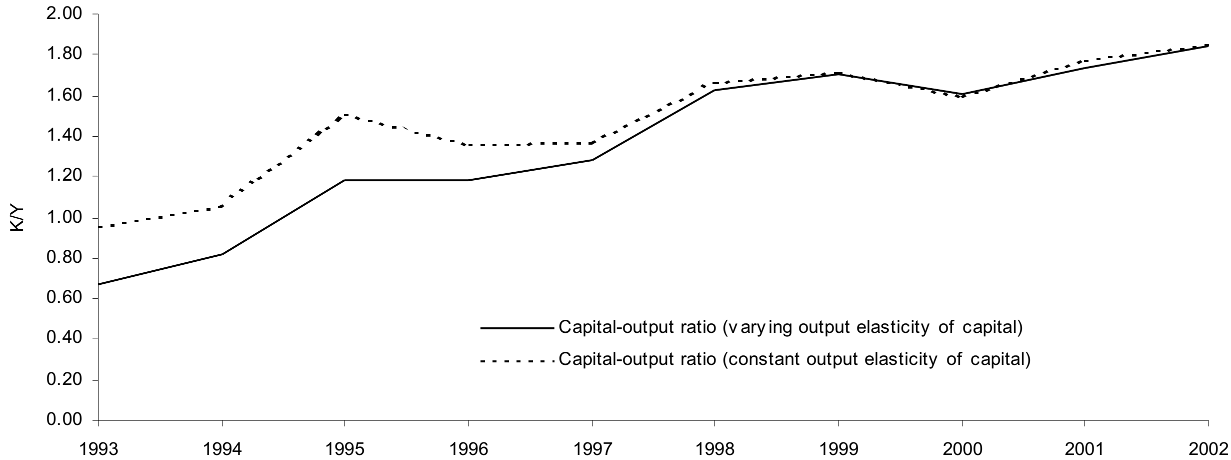
$$(1+r(t))\,p_i(t) = p_k(t) + (1-\delta)\,p_i(t),$$

or

$$p_k(t) = (r(t) - (p_i(t) - p_i(t-1))/\,p_i(t-1))\,p_i(t-1) + \delta p_i(t),$$

where $p_i(t)$ denotes the investment price at time t. We take the lending rate for long-term loans of capital assets as the relevant interest rate for capital.[38] As the price of capital goods we take the implicit deflator for gross fixed capital formation from the National Accounts. Using a depreciation rate of δ of 0.075 as before, we can calculate the nominal user cost of capital.[39] However, capital is accumulated until the marginal product of capital equals the nominal user cost of capital over

Figure 9: **Capital stock using the marginal productivity condition**



Source: Own calculations.

[38] See Table 2.4.1 in the Monthly Bulletin of the Bank of Slovenia.

[39] We assume that individuals have perfect foresight regarding investment prices. We could try to model investment price expectations with an ARIMA specification. However, substantial swings in inflation rates (with annual inflation rising up to 1000+%!) probably imply that there is little to gain from this approach.

the price of output. Figure 8 plots the 'real' user cost of capital, the nominal user cost of capital deflated by the GDP deflator.

Figure 8 suggests a substantial fall in the user cost of capital over the period 1993-2002, reflecting the net effect of a fall in interest rates and inflation in investment prices.[40] Indeed, there was a substantial drop in real interest rates, due to *e.g.* a declining risk premium or opening up of financial markets. The user cost drops from 0.32 in 1993 to 0.16 in 2002.

Finally, assuming that our constructed series for the capital income share and the user cost of capital are correct, and assuming that capital is paid its marginal product, Figure 9 shows the capital-output ratio implied by the optimality condition for a Cobb-Douglas production function (*i.e.* the capital income share over the user cost of capital).

Using either the actual capital income shares over the period 1993-2002 for the elasticity of output with respect to capital, or assuming a constant elasticity of output with respect to capital of 0.3, we find a dramatic rise in the capital-output ratio – from 0.67 in 1993 to 1.85 in 2002 using the former, and from 0.95 in 1993 to 1.85 in 2002 using the latter, see Figure 9. The end values are perhaps not too far from the series in the previous subsection, 2.14, the starting values are much lower though. Even the capital series from the optimality condition using a constant elasticity of output with respect to capital of 0.3 suggests an annual growth in the capital-output ratio of 8% over the period 1993-2002. This seems unrealistic. The results are probably more informative about the difficulties of determining the elasticity of output with respect to capital and calculating the user cost of capital in the rather volatile early 1990s, than about the growth in capital.

2.4.3. Comparison with other studies

The growth in the capital series after 1993 is somewhat higher in this paper than in related studies

The perpetual inventory method suggests an annual growth of the capital stock of 6.8% over the period 1993-2002. The optimality condition suggests a much higher growth rate, but the marginal product and the marginal cost of capital are rather hard to determine in the early years following the transition. Below we therefore use the capital stock series from the perpetual inventory method. Supporting 'evidence' comes from capital series constructed for Slovenia by other authors.

Bovha Padilla and Padilla Mayer (2002) obtain a value for the capital-output ratio of 1.5 in 1992, their base year. Our capital series has 1.7 in 1992, somewhat higher. They use the optimality condition to determine this initial capital-output ratio. As we saw above, this produces a relatively low capital-output ratio in the early 1990s. Over the period 1992-2000 Bovha and Padilla (2002) calculate a much lower growth in capital of 1.1% per year, compared to 6.2% in our series. The low growth in Bovha Padilla and Paddila and Mayer (2002) is a bit puzzling given that their initial capital stock is lower whereas they use the same national accounts for subsequent investments.

[40] The user cost of capital is close to but not exactly the same as the sum of the real interest rate and the depreciation rate used in Mrkaic (2002) and Bovha Padilla and Padilla Mayer (2002), see also Figure 8. The difference is due to a difference in the inflation rate implicit in the user cost of capital, derived from investment prices, and the inflation used by the Bank of Slovenia to calculate the real interest rate, derived from consumer prices.

In preliminary work Mićković and Vasle (2004) calculate a capital-output ratio of 1.43 in 1996, compared to 1.73 in our series. For the period 1992-2002 they further calculate an average annual growth of capital of 6.0%, compared to 6.4% in our series. Below we are mostly interested in the growth rate of capital, which is quite similar.

Doyle *et al.* (2001) obtain a value for the capital-output ratio of 2.11 in 1996, compared to 1.73 in our series. They further calculate an average annual growth in capital over the period 1992-2002 of 4.1%, compared to 6.4% in our series. Their growth rate is quite a bit lower. This is likely to be due to their relatively high starting value. Their capital series starts in 1985, where they assume that the capital-output ratio in Slovenia was the same as in Hungary. This may be too favourable. A growth of 4.1% implies, for example, that there was virtually no capital-deepening over this period. This does not seem to accord with the decline in the user cost of capital over the period 1992-2002.[41]

Finally, Piatkowski (2003) obtains a value of 2.28 for the capital-output ratio in 1996, compared to 1.73 in our series. For the period 1995-2000 he finds an average annual growth of capital of 5.3%, compared to 7.5% in our series. Perhaps the difference is due to the different data sources used. We use national accounts of Slovenia directly, Piatkowski (2003) uses them indirectly (investment series are taken from the World Development Indicators, 2003). Another difference is the assumed drop in the capital stock during the late 1980s/early 1990s. Piatkowski (2003) assumes a one-off drop of 25%, we raise the depreciation rate by 7.5% over a five year period, a cumulated additional drop in capital of 32%.

[41] Furthermore, the share of gross fixed capital formation in GDP in real terms was on average 24% in Slovenia over the period 1993-2002, compared to just 20% in the EU-15 (source: Eurostat, 30-04-2004). This also suggests capital deepening in Slovenia, given that we do not expect Slovenia to have started with a higher capital-output ratio than the EU-15 average in 1993.

We do not reject that the production function is Cobb-Douglas

Intermezzo: **Substitutability between capital and labour**

In the next section we consider the individual contributions to GDP growth of the inputs considered above. However, we first take a detour to consider the functional form of the aggregate production function. This will have some relevance for the growth accounting exercise below, but is mostly relevant for the subsequent projections for the future.

Suppose that aggregate output *Y(t)* at time *t* is given by the CES-function

$$Y(t) = A_Y(t)\left(\beta(A_N(t)N(t))^{\gamma} + (1-\beta)(A_K(t)K(t))^{\gamma}\right)^{\frac{1}{\gamma}},$$

where $A_Y(t)$, $A_N(t)$ and $A_K(t)$ denotes neutral, (effective) labour and capital augmenting progress respectively, *N(t)* and *K(t)* denote (effective) labour and capital, β and γ a parameter where γ determines the elasticity of substitution between labour and capital $\eta \equiv \gamma/(\gamma-1)$. In the analysis below we are mostly interested in whether γ differs significantly different from 0, in which case the CES-production function above reduces to the more convenient Cobb-Douglas function (see *e.g.* Barro and Sala-i-Martin, 1998)

$$Y(t) = A_Y(t)(A_N(t)N(t))^{\beta}(A_K(t)K(t))^{1-\beta}.$$

Cost minimisation given labour costs and the user cost of capital gives expressions for labour and capital demand. Unfortunately, the capital demand equation gave poor results. This is likely to be the result of the user cost series, in which we do not have great faith, in particular at the beginning of the series (see above). Therefore, we focus on the substitution elasticity implied by the estimated labour demand equation.

Denote average labour costs by *wc(t)*.[42] Furthermore, suppose that $A_Y(t)$ and $A_N(t)$ are of the form $A_x(0)(1+g_x)^t$ with g_x sufficiently small so that $log(1+g_x) \approx g_x$. Starting with the CES-production function above, cost minimisation gives the following relation between the demand for (effective) labour and labour costs.[43]

$$\log(wc(t)) = c' + \gamma(g_Y + g_N)t + (\gamma-1)\log(N(t)/Y(t)) + \varepsilon_t',$$

where $c' \equiv log(\beta(A_Y(0)A_N(0))^{\gamma})$, g_Y and g_N denote the growth rate in neutral and labour augmenting technological change, and ε_t' denotes an (identically and independently distributed) error term.

The estimation results are given in Table 2. For comparison, Hamermesh (1993) suggests a reasonable guess for the substitution elasticity between labour and capital is about –1, or γ=0 (the Cobb-Douglas case). When we use employment (in FTE) for the period 1993-2002, we find a value for γ of -0.06, very close to the Cobb-Douglas case (indeed the estimate does not differ significantly from –1 (γ=0). When we use the labour composite with employment (in FTE) multiplied by the

[42] For 1995-2002 we take labour costs per employee of rapid report no. 112 of the SORS. For 1993-1994 and 2001-2002 we calculate labour costs using compensation of employees in the National Accounts plus 'employers' payroll taxes' (introduced in 1994) and taking the corresponding number of employees of the national accounts. The two series are very close in 1995 and 2000 (in both years the difference is less than 1 percent).

[43] We rewrite the first-order condition to labour costs, believing that it is in fact labour that is exogenous and wages that are endogenous.

Table 2: **Substitutability between labor and capital**

Estimated parameter	γg	γ-1	R^2	Durbin-Watson
Using employment	-0.011 (0.018)	-1.062 (0.472)	0.98	1.10
Using the labor composite	0.009 (0.006)	-0.915 (0.246)	0.99	1.33

Note: Standard errors in parentheses; estimation period: 1993-2002.

CES-weighted human capital index of low- and high-skilled workers (our preferred series for the human capital index, see above), we again do not reject that $\gamma=0$.[44]

In the regression with employment as the explanatory variable we find an insignificant negative trend, in the regression with the labour composite as an explanatory variable we find a small positive trend. Note that when γ is indeed 0, we have to be careful with the interpretation of this trend, as g_Y and g_N multiply with γ. What then could the trend represent? One reason why we might expect a negative trend is an issue pursued in Jongen (2004b). There we argue that explaining the rise in the labour income share with changes in the capital-output ratio and the substitutability between labour and capital would require unrealistic changes in the capital-output ratio and/or the substitution elasticity. A more natural explanation for the rise in the labour income share in the late 1980s/early 1990s and the subsequent drop is that labour was able to claim more than its marginal product initially, which was followed by a correction in the subsequent period.[45] The estimation period considered above deals with the 'subsequent period' when wages moved back to the marginal product of labour again. Does this not affect the estimation results for the substitution elasticity? Not necessarily, as long as only the intercept and the trend are affected. Another way to reconcile a trend, in this case negative or positive, with a Cobb-Douglas substitution elasticity would be to assume structural changes that led to a change in the elasticity of output with respect to labour and capital. It is often argued that production in socialist economies favoured manufacturing over services. During the transition some of this imbalance with market economies was restored. This could be another explanation for the trend.[46]

One should be careful putting any great store in these estimates, however. Consider for example the estimation with the (log of the) employment-output ratio. Although we do not have enough observations to formally test it, an analysis of the available observations suggests that the series are not stationary in the level (and perhaps the first differences). Hence, the estimates might be spurious (consider also the high R^2 and the relatively low Durbin-Watson statistic). However, the residuals of the estimation of labour costs on the employment-output ratio appear to be stationary. Hence, we do not reject that the series are cointegrated (details available on request). What do we make of this? When we consider the question of whether we reject the null hypothesis that an aggregate production function with capital and labour can be approximated by a Cobb-Douglas production function, we do not. In the absence of evidence to the contrary, we therefore proceed on the assumption that the aggregate production function can be approximated by a Cobb-Douglas function of (effective) labour and capital.

[44] One issue is a potential correlation between the explanatory variable and the error term. Estimating the relations with 'two stage least squares', using lagged explanatory variables as instruments lowers the estimate of γ to -0.36 in the estimation using employment, and raises the estimate of γ to 0.44 in the estimation using the labour composite. None of these estimates for γ differs significantly from 0 though.

[45] Labour derived its power to move off the labour demand curve in the medium run from strict firing legislation.

[46] We are trying to get away with murder here.

The main driving forces behind GDP growth over the period 1993-2002 were physical and human capital accumulation, TFP growth declined

3. Growth accounting

Using the inputs constructed and analysed in Section 2 we can now use growth accounting to determine the main determinants of output growth. Indeed, for a factor to be important in past growth it must have had substantial growth itself *and* be relatively important for production. Furthermore, using growth accounting we can determine the growth in total factor productivity (TFP), the residual.

For growth accounting we do not need to know the exact form of the production function, although it is convenient when it has constant returns to scale and factors are paid their marginal products (see Barro, 1998, for an excellent overview) which we shall assume below. Suppose that output is a function of total factor productivity, the labour composite and capital

$$Y(t) = f(A(t), N^e(t), K(t)).$$

Taking the derivative with respect to time, and dividing by output we have

$$\overset{\circ}{Y}(t)/Y(t) = f'_A(t)A(t)/Y(t)\,\overset{\circ}{A}(t)/A(t)$$
$$+\ f'_{N^e}(t)N^e(t)/Y(t)\,\overset{\circ}{N^e}(t)/N^e(t)$$
$$+\ f'_K(t)K(t)/Y(t)\,\overset{\circ}{K}(t)/K(t).$$

Next assume that technological change is neutral so that $f'_A(t)A(t)/Y(t)$ is 1[47], that labour is paid its marginal product so that $f'_N(t)N(t)/Y(t)$ equals the labour income share in output *lis(t)* and that *f(.)* has constant returns to scale and capital is also paid its marginal product so that $f'_K(t)K(t)/Y(t)$ is 1-*lis(t)* (by Euler's Rule which tells us that $f'_N(t)N(t)+f'_K(t)K(t) = f(.)$ when *f* has constant returns to scale), we have

$$\overset{\circ}{A}(t)/A(t) = \overset{\circ}{Y}(t)/Y(t) - lis(t)\,\overset{\circ}{N^e}(t)/N^e(t) - (1-lis(t))\,\overset{\circ}{K}(t)/K(t),$$

once we rewrite the accounting relation to the residual TFP growth. We then use the following discrete time approximation for this relation (to take into account that the 'weights', *i.e.* the labour income share, may change from one discrete point in time to the next, see Barro and Sala-i-Martin, 1998, p. 347)[48]

$$\log(A(t)/A(t-1)) = \log(Y(t)/Y(t-1))$$
$$-((lis(t)+lis(t-1))/2)(\log(N^e(t)/N^e(t-1))$$
$$-((1-lis(t))+(1-lis(t-1))/2)(\log(K(t)/K(t-1)).$$

Table 3 gives the resulting contribution of labour, human capital, physical capital and the residual TFP in GDP growth over the period 1993-2002 for different series for human and physical capital. All series use employment in FTE for 'raw' labour, which is multiplied with the respective human capital index series.

[47] A very similar expression results if we assume (only) labour augmenting technological change.

[48] The discrete time approximation is only exact for the translog production function, see Diewert (1976).

Table 3: **Growth accounting, in %, 1993-2002**

Contribution by	**Labor**	**Human Capital**	**Physical Capital**	**TFP**		**GDP**
Series 1[1]	0.1	1.1	2.0	0.8		4.1
Series 2 (1993-2001)[2]	0.2	1.2	2.0	0.8		4.2
Series 3[3]	0.1	0.3	2.0	1.6		4.1
Series 4[4]	0.1	1.1	1.2	1.6		4.1
Series 5[5]	0.1	0.0	2.0	1.9		4.1

Notes:
[1] Series 1 uses employment in FTE, the CES-composite of low- and high-skilled labor for the human capital index and the preferred capital series using the perpetual inventory method.
[2] Series 2 uses employment in FTE, average wages of workers relative to the wages of the unskilled for the human capital index and the preferred capital series using the perpetual inventory method. Note that this series runs only until 2001.
[3] Series 3 uses employment in FTE, the Hall and Jones (1999) transformation of average years of schooling for the human capital index and the preferred capital series using the perpetual inventory method.
[4] Series 4 uses employment in FTE, the CES-composite of low- and high-skilled labor for the human capital index and growth in capital equal to the growth in output.
[5] Series 5 uses employment in FTE, ignores the increase in human capital (ends up in TFP) and the preferred capital series using the perpetual inventory method.

Furthermore, we use a constant of 0.7 rather than the actual labour income share for all series, assuming that the labour income share was not a very good indicator of the elasticity of output with respect to labour (and its complement for capital in the early 1990s). As already noted above, in Jongen (2004b) we show that the movements in the labour income share are not compatible with realistic assumptions about the changes in the capital-output ratio and the substitution elasticity between (effective) labour and capital over this period. Using the actual labour income shares for the elasticity of output with respect to labour (and indirectly for capital) hardly affects the numerical, and none of the qualitative, results. Capital growth was relatively small at the beginning, when its income share was also relatively low.

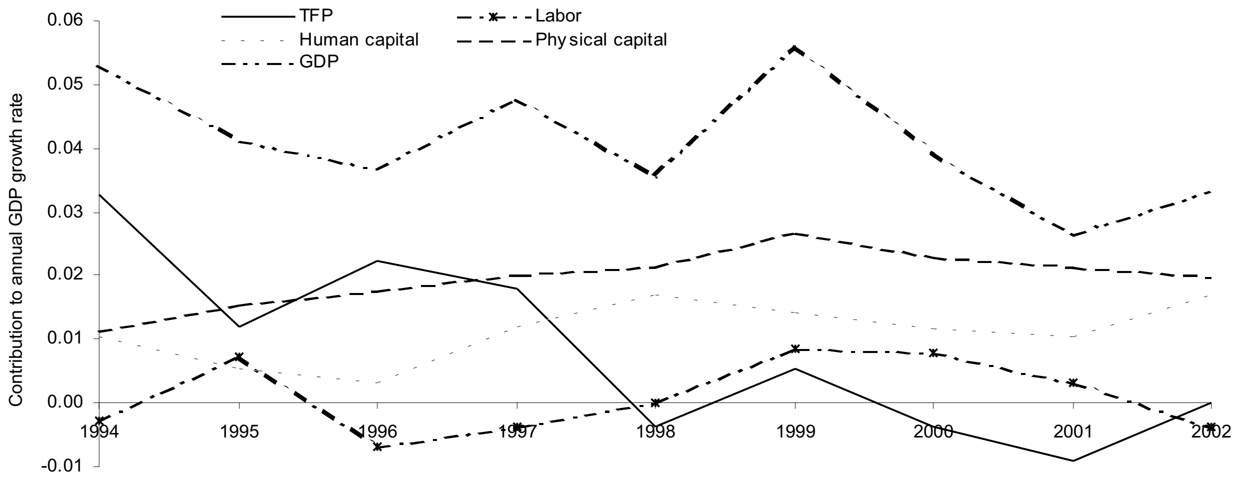
Series 1 uses the CES-composite of low- and high-skilled labour for the human capital index and the capital series from the perpetual inventory method, our preferred series for both variables. We find that capital was the most important driving force behind the high GDP growth in this period, although its ‘weight’ of 0.3 limits its contribution (remember that our capital series had 6.8% growth in this period). Second place is for human capital. This is mostly due to the skill-biased technological change incorporated in this human capital index. Third is TFP, while employment growth made almost no contribution to output growth.

Series 2 uses average wages relative to the wages of the unskilled for human capital, as well as our preferred capital series. In this case, the contributions of the various factors are about the same. Note that this human capital series also includes skill-biased technological change.

Series 3 uses average years of schooling for human capital, and our preferred capital series. In this case human capital makes a smaller contribution to GDP growth, and hence more is left for TFP. Physical capital accumulation is still the most important contributor to GDP growth though.

Series 4 and 5 consider two further alternatives. In Series 4 we assume there was no capital deepening, *i.e.* the capital-output ratio remained unchanged. In this case, TFP becomes the main contributor and physical capital accumulation and human capital (including skill-biased technological change) are about equally important

Figure 10: **Contributors to GDP growth over time, preferred series**



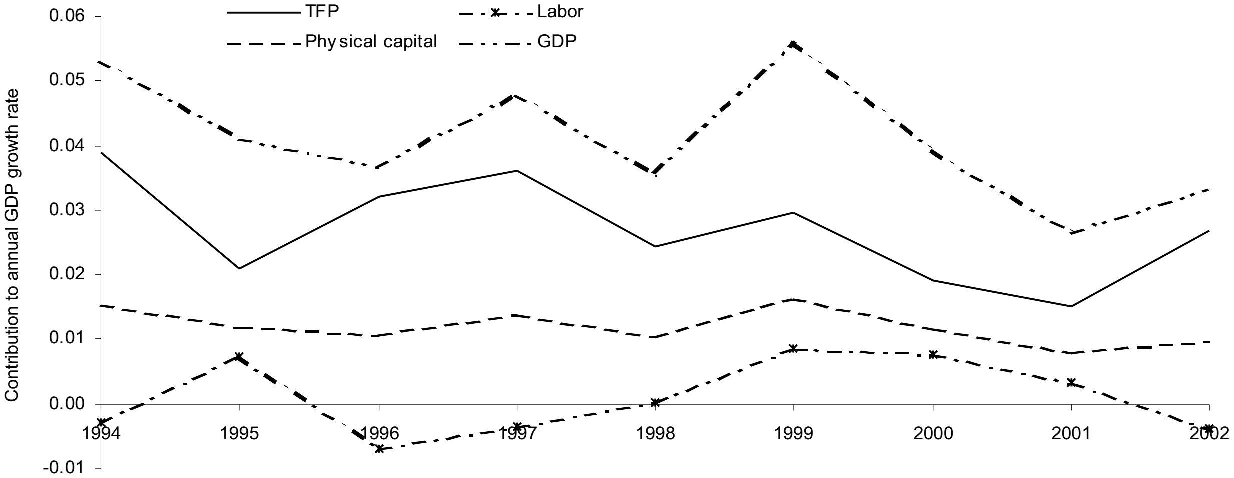
Source: Own calculations using growth accounting.

for past GDP growth. Series 5 considers TFP growth when we abstract from human capital accumulation (for completeness, as many (older) growth accounting studies do not consider human capital). In this case, the 'contribution' of the residual TFP growth is almost the same as the contribution of physical capital growth.

The decompositions above suggest that physical capital accumulation was the most important contributor to growth (the fall in the user cost of capital and perhaps a decline in the capital-output ratio in the late 1980s make it likely that capital grew faster than output over the period 1993-2002), and human capital was second (provided that we incorporate skill-biased technological change in the human capital index).

The time pattern of growth in TFP over the period 1993-2002 is rather worrisome. Figure 10 gives the annual contribution to GDP growth over the period 1993-2002 using the preferred series for human and physical capital. Figure 11 gives a 'counterfactual' where we assume there was no capital deepening and no growth in human capital.

Figure 11: **Contributors to GDP growth over time, no physical capital deepening and no human capital growth**



Source: Own calculations using counterfactual growth accounting.

GDP growth slows down at the end of the period, whereas physical capital growth remains high and human capital growth picks up. Although the decline in TFP may be largely cyclical, Figure 10 does suggest there is a downward trend in TFP growth over the period in consideration. This is in line with the findings of Mrkaic (2002). Only in the extreme case where we assume that there was no capital deepening and no human capital growth does it become hard to discern a downward trend in TFP growth, see Figure 11.

4. Base projection for the period 2002-2013

After considering the determinants of GDP growth in the past we now turn to the determinants of GDP growth in the future. Using an educated guess for the growth of inputs in the future we make a projection for future GDP growth.[49] We focus on the period up to 2013, the end of the period under consideration in the new strategy for the Slovenian government.

4.1. Organising framework

In the *Intermezzo* above we concluded that we do not reject the Cobb-Douglas function for aggregate output. Hence, we use the following functional form for output

$$Y(t) = A(t)(HC(t)N(t))^{\beta}(K(t))^{1-\beta},$$

where *N(t)* denotes 'raw' labour and *HC(t)* denotes the human capital index. We focus on a projection for the *average* annual growth rate for the inputs over the period 2002-2013. Hence, we abstract from year-to-year changes in projected growth rates. Indeed, projected annual growth rates are more likely to be off than the average up to 2013. This method implies, however, that our average growth rates will not fall over time even if, for example, we expect the growth rate of capital to be higher in the beginning than the end. This is only a problem if we wish to extend the projection beyond 2013 however.

Using the Cobb-Douglas function we do not have a problem with 'weights' in calculating future growth, and output growth is an additive expression of the growth in the respective inputs

$$g_y = g_A + \beta g_{HC} + \beta g_N + (1-\beta) g_K,$$

where g_x denotes the growth rate of *x*. We develop this expression a little further because it will be useful to introduce a help variable for the capital-output ratio $\varphi(t) \equiv K(t)/Y(t)$. Substituting $\varphi(t)Y(t)$ for *K(t)* in the production function, taking all expressions for *Y(t)* to the left hand side and then taking the derivative to time we get an alternative expression for the growth rate of output

$$g_y = (1/\beta) g_A + g_{HC} + g_N + ((1-\beta)/\beta) g_{\varphi},$$

where we use the growth in the capital-output ratio rather than the growth in capital. The motivation for this is that the capital-output ratio is typically assumed to tend to a constant along the balanced growth path of market economies (one of Kaldor's (Kaldor, 1963) infamous stylised facts, see also Barro and Sala-i-Martin, 1998). The expression above takes this into account. In particular, higher growth in TFP or effective labour also leads to higher capital growth, to keep the capital-output ratio constant. In addition, we can separate these effects from the projected further capital deepening in the Slovenian economy (see below).

[49] Some would refer to this as 'potential GDP growth', because we do not consider the role of the business cycle. However, it would be hard to predict the state of the business cycle in 2013 relative to 2002. Further, over a sufficiently long period of time, business cycle swings in output are relatively small compared to the cumulated growth in GDP.

4.2. Projection for growth in employment

Employment growth is expected to remain low.

For the growth in employment and education we take the 'trend' projection of Kraigher (2004). For employment we use the projected growth rate of employment in persons as a proxy for the projected growth rate of employment in full-time equivalents.[50] Kraigher (2004) projects the population to fall, by 3,800 people between 2002 and 2013, an annual decline of 0.02%. The gross participation rate is expected to increase slightly, from 67.8% to 68.3%. This is the net effect of an ageing working population (reducing gross participation) and the higher participation of workers aged 25 and over, in particular by workers aged 55-64. The overall result is a drop in gross participation in persons by 6,000. Regarding net participation however, Kraigher (2004) projects a further drop in the unemployment rate from 6.4% in 2002 to 4.5% in 2013, due to demographic factors (older workers have lower unemployment rates than younger workers). As a result, employment grows by 12,200 persons over the period 2002-2013. The corresponding annual growth rate over the period 2002-2013 is 0.12%. As in the period 2002-2013, employment growth is not projected to be one of the main driving forces of GDP growth.

4.3. Projections for growth in human capital

The growth in human capital is expected to accelerate

We consider projections for the three human capital indices of Section 2.3: i) average years of schooling; ii) average wages relative to wages of the least skilled; and iii) the CES-weighted composite of low- and high-skilled workers.

In the 'trend' scenario of Kraigher (2004), the average years of schooling rises from 11.6 years to 12.4 years. The growth rate in the corresponding Hall and (1999) transformation is 0.5%, 0.1% higher than in the period 1993-2002 (on average).

Kraigher (2004) also has a projection for the shares of the various types of education in Slovenia. Furthermore, we have the growth in wages relative to the unskilled over the period 1993-2001 from Table 13.5 of SORS (2003). We use the growth in wages relative to the unskilled to calculate an index for 'skill-biased technological change' per type of education and then extrapolate these to the future. Combining the resulting projected wages per education type with the projected shares of Kraigher (2004), we come to a projection of the average wage relative to the least skilled. This human capital index grows at an annual rate of 0.025 (see the Excel file mentioned in Footnote 1 for details). This is significantly higher than in the past (0.015), due to the projected increase in highly educated workers combined with skill-biased technological change for higher educated workers.

Finally, we consider the projected growth in the CES-weighted composite of low- and high-skilled labour. In the 'trend' scenario, Kraigher (2004) projects the share of tertiary-educated workers to rise from 18.4% in 2002 to 28.7% in 2013. Assuming that skill-biased technological growth for individuals with a tertiary education will continue at an annual rate of 0.017[51], the projected annual growth in this human

[50] We further do not consider changes in the average number of working hours per full-time equivalent. Our past employment series also did not take this into account. Below we extrapolate TFP growth from the past into the future, as the residual this implicitly takes into account any change in projected average working hours for a worker that works full-time (and assuming there will be no change in the past trend). According to sources at IMAD, the average number of working hours for a full-time equivalent per week fell from 43.9 in 1993 to 41.5 in 2002.

[51] And assuming that $\gamma = 0.33$, see Section 2.3.3.

capital index is 2.3%. Hence, also according to this indicator we project higher growth in the human capital index in the future than in the previous period (1.6% over the period 1993-2002). Without a rise in the share of the tertiary educated, the index would still grow at 1.6% per year on average over the period 2002-2013 due to skill-biased technological change.

4.4. Projection for growth in physical capital

There is still some room left for further capital deepening

Two key factors play a potential role in the future regarding capital accumulation: i) has the capital-output ratio in Slovenia recovered from the transition?; and ii) do we expect a further fall in the user cost of capital in Slovenia?

In Section 2.4 we calculated that the capital-output ratio in Slovenia in 2002 is somewhere in the order of 2.14, coming from around 1.70 in 1993. Jongen (2004b) compares this capital-output ratio with those reported by Hall and Jones (1999) for EU-15 countries, whose weighted average is 2.4 (using population of Groningen Growth and Development Centre (2004) as weights). Hence, provided that the long-run capital-output ratio is somewhere in the vicinity of the EU-15 average, the capital-output ratio in Slovenia has largely recovered from the transition, but there is still some room for further capital deepening left.

The real interest rate tells a similar story. The real interest rate was still relatively high in 2002, which suggests that the user cost of capital remained relatively high. In 2002 the real interest rate on long-term capital loans was on average 7.4%, compared to 3.4% in the euro-zone.[52] By December 2003 the real interest rate on long-term capital loans had already fallen to 5.2% in Slovenia.[53]

Let us suppose that the capital-output ratio will converge to the EU-15 average of Hall and Jones (1999), 2.4, over the period 2002-2013. Starting with a capital-output ratio of 2.14 in 2002, I calculate an average annual growth in the capital-output ratio of $(\exp(1/11*\log(2.40/2.14)) - 1) * 100\% = 1.05\%$ to reach 2.40 by 2013.

4.5. Projection for total factor productivity

TFP growth is assumed to be somewhat lower than in the period 1993-2002

Finally, what do we expect for the growth of total factor productivity? Over the period 1993-2002 we found that, when using the CES-weighted series for human capital, the ‘average wages relative to the wages of the unskilled’ series and average years of schooling led to respective growth in TFP of 0.8, 0.8 and 1.6%. However, from Figure 10 we concluded that 1994 might be an outlier. Excluding 1994 we find growth in TFP of 0.5, 0.3 and 1.3%, respectively. This suggests that extrapolating TFP growth from the past would be too favourable. But then again, the low TFP growth in the last years is likely to partly reflect the business cycle downturn. Furthermore, increased trade with the EU may speed up convergence with the EU (see *e.g.* Ben-David, 2000). Indeed, the international growth accounting exercise in Jongen (2004a) suggests there is still a substantial remaining gap in TFP relative to the EU-25 on average. Based on these considerations we prefer

[52] Source: Eurostat (30-09-2004). We subtracted the average annual rate of change in the harmonized price index of the euro-zone from the average nominal interest rate on long-term capital loans.

[53] Source: Bank of Slovenia (www.bsi.si, 30-04-2004).

to use 0.5% of TFP growth in the future when using the CES-weighted human capital index, 0.3% when using the average wages human capital index, and 1.3% when using average years of schooling. Hence, I exclude the 'outlier' 1994, but do not assume a downward trend. We consider the impact of lower and higher TFP growth in the sensitivity analysis below.

4.6. Base projection for output

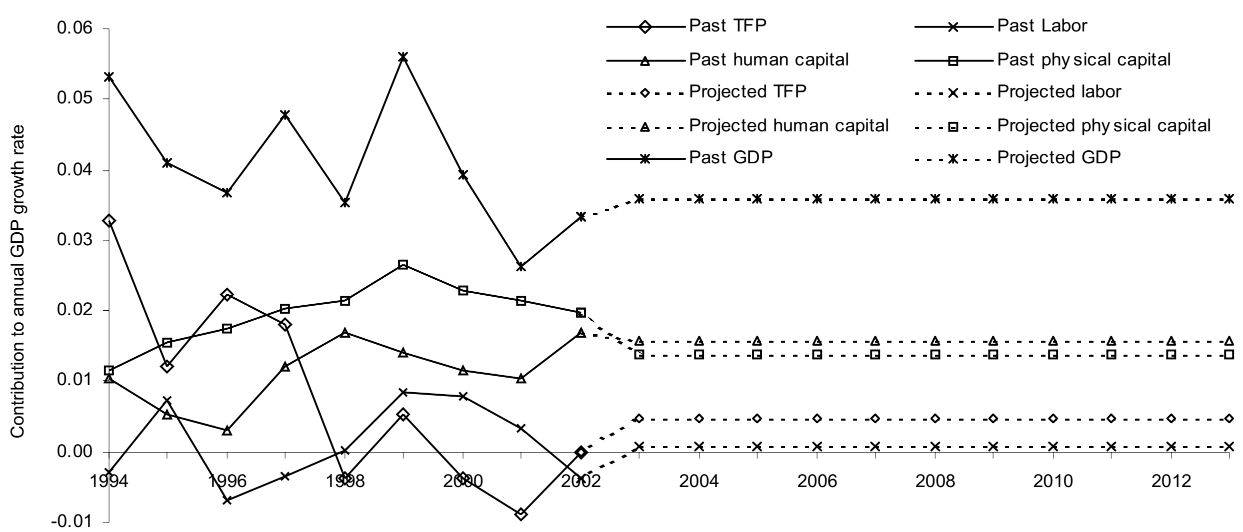
Using the projected inputs above we make a projection for GDP growth. For the period 2002-2013 we project an average annual growth in labour of 0.12%, in the capital-output ratio of 1.05% (*i.e.* we project capital to grow 1.05% faster than GDP annually), and in TFP of 0.5% when we use the CES-weighted human capital series, 0.3% when we use the average wages relative to the wages of the least-skilled human capital series, and 1.3% when we use average years of schooling for human capital. Furthermore, we expect the CES-weighted index of human capital to grow at 2.3% per year, the average wages relative to the wages of the least skilled to grow at 2.5% per year and the average years of schooling index to grow at 0.5% per year. We assume that the production function is Cobb-Douglas with constant returns to scale and the elasticity of output with respect to labour is 0.7.

GDP growth is projected to be somewhat lower, 3.6%, mostly due to lower capital deepening than in the past

Using the CES-weighted composite of low- and high-skilled labour for the human capital index, we then project an average annual GDP growth of 3.6% over the period 2002-2013. Using the average wage relative to the least skilled gives 3.5% and using average years of schooling gives 2.9%. In the last case, the drop in capital accumulation is only partly compensated for by the higher human capital growth.

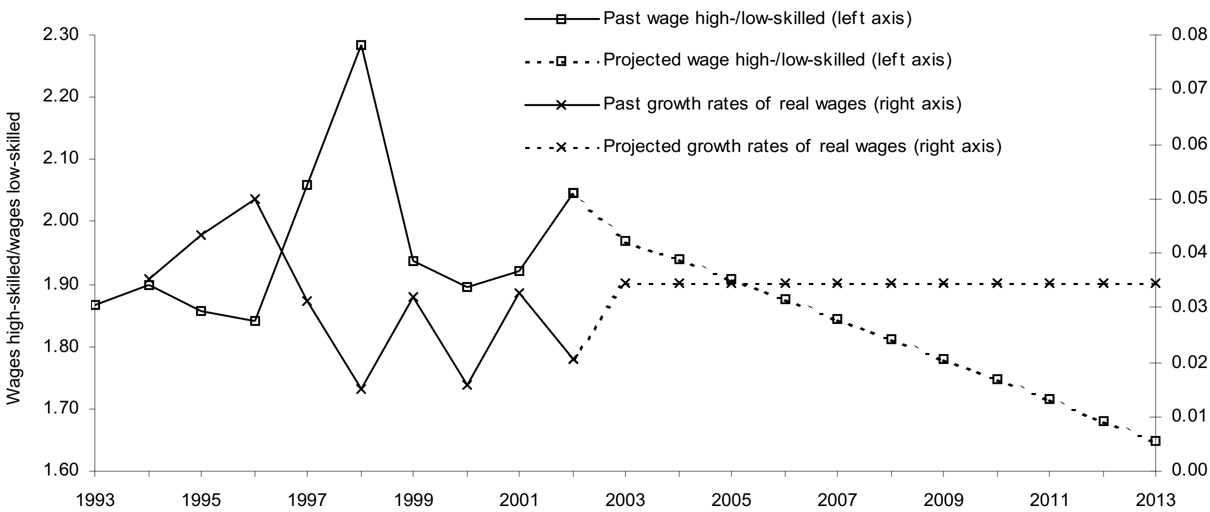
Hence, we project GDP growth to slow down somewhat compared to the period 1993-2002. This is the result of lower projected capital deepening in the future than in the past, this drop dominates the projected increase in the growth rate of human capital. The projected growth rates are still impressive though. Using our preferred CES-weighted human capital series, Figure 12 puts the contributions of

Figure 12: **Growth accounting of past and projected GDP growth**



Source: Own calculations using growth accounting.

Figure 13: **Projected wages**



Source: Own calculations.

the various factors in projected GDP growth in a historical perspective. Note that the smooth patterns after 2002 are an artefact of transforming year-to-year growth rates up to 2013 into an average annual growth rate for all the inputs. Figure 12 illustrates the reversing roles of human and physical capital accumulation in the past and in the projected future (with human capital including skill-biased technological change).

Wages of high-skilled workers are projected to fall relative to low-skilled workers

Figure 13 puts the projection for average real wage growth and the ratio of wages of high- to low-skilled workers into a historical perspective. Over the period 1993-2002 wages grew at 3.1% per year[54], for the future we project wages to grow at 3.5%.[55] Figure 13 further shows that we project a reversal in the trend of high- to low-skilled wages. In the past, skill-biased technological change outpaced the increase in the relative supply of skilled workers. In the future we project that the rise in the growth of high-skilled workers will dominate the effect of skill-biased technological change.

The investment-output ratio can be a bit lower than in recent years

Finally, Figure 14 gives a projection of the investment-output ratio (in real terms, both series are expressed in 1995 SIT). We can compute the corresponding projected investment-output ratio from the capital accumulation equation, using the fact that for simplicity we assume growth rates to be constant. Capital accumulation follows from (see Section 2.4.1)

$$K(t) = (1-\delta)K(t-1) + I(t),$$

Rewrite this to investment to obtain

$$I(t) = K(t) - (1-\delta)K(t-1).$$

Noting that capital grows g_φ faster than output we can rewrite this to

$$I(t) = K(t)(1-(1-\delta)/((1+g_y)(1+g_\varphi))).$$

[54] Over the 1993-2002 period, wages grew less than output per worker.

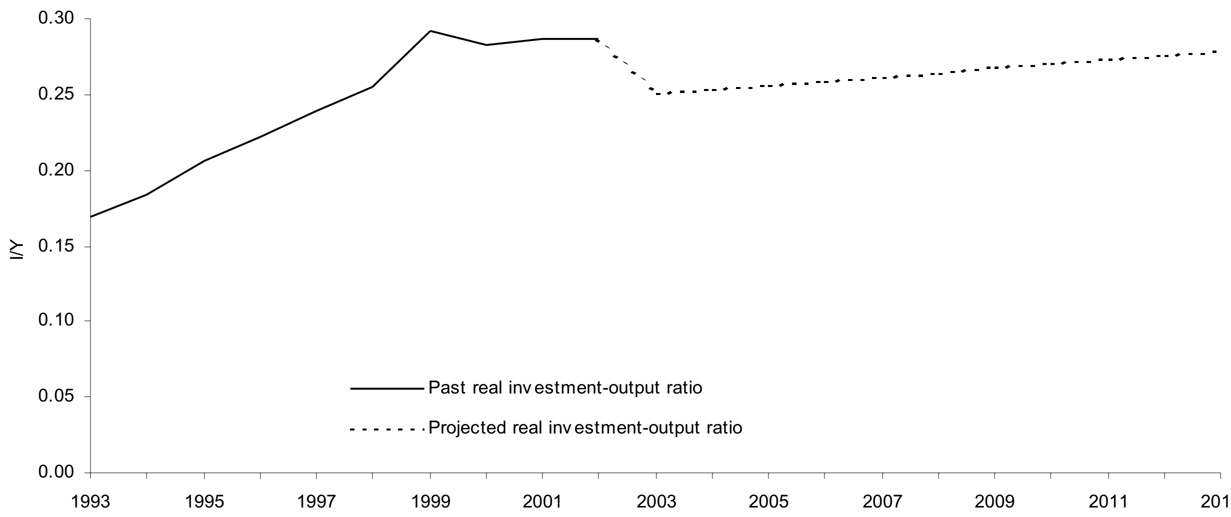
[55] In the Cobb-Douglas case the growth rate of wages is the growth rate of output minus the growth rate of employment.

Dividing by output and noting that $K(t)/Y(t) = K(0)/Y(0)(1+g_\varphi)^t$ we obtain

$$I(t)/Y(t) = K(0)/Y(0)(1+g_\varphi)^t(1-(1-\delta)/((1+g_y)(1+g_\varphi))).$$

Figure 14 plots the resulting series starting with a capital-output ratio of 2.14 in 2002 and a depreciation rate of 0.075. Figure 14 suggests that the real investment-output ratio may fall in the future compared to the recent past (1999-2002). This is the result of a slowdown in capital deepening. Note that the relation above further suggests a mild increase in the investment-output ratio. This is however an artefact of the fact that we assume there will be gradual capital deepening up to 2013. If most of the capital deepening were to take place in the early years, we would obtain a perhaps more realistic flattening-out pattern of the investment rate. Here we are mostly interested in the average increase in the investment-output ratio over the whole period 2002-2013 though.

Figure 14: **Investment-output ratio**



Source: Own calculations. **Note**: The investment-output ratio is in real terms (in 1995 SIT).

5. Sensitivity analysis of base projection[56]

Our base projection with the preferred series for human capital suggests that Slovenian real GDP will grow at about 3.6% per year over the period 2003-2013. In this section, we consider the sensitivity of this projection to some alternative developments in the inputs in the past and future.[57] Furthermore, we also briefly compare our base projection with the projected growth rates in some related studies on Slovenia.

5.1. Sensitivity to alternative developments in the past

The most uncertain factor for future growth rates is past capital growth. For all other factors projected growth stays in the band of 3.1% to 4.0%

We do not consider the sensitivity of the projection to alternative labour and TFP growth in the past. The growth of labour is presumably measured quite accurately, whereas alternative developments in TFP growth would merely reflect alternative developments in the other inputs (it is calculated as a residual). We consider the sensitivity to alternative *future* labour and TFP growth in the next subsection. The focus here then is on alternative developments in human and physical capital in the past.

Regarding human capital we will focus on our preferred series for human capital growth in the past, the CES-composite of low- and high-skilled labour. We first note that for any input that would grow at the same rate in the future as it did in the past, alternative growth rates from the past would have no effect on the base scenario. This is because a change in the growth rate of this input in the past leads to an offsetting change in the growth rate of TFP in the past, and the TFP growth of the past is used to project TFP growth in the future. However, in the base projection the growth rate of human capital is projected to rise from 1.6% over the period 1993-2002, to 2.3% per year over the period 2002-2013. Hence, different paths for past human capital growth will imply different paths for projected real GDP growth. As a reasonable alternative development in human capital in the past let us again consider the estimation results of Table 1. In our preferred series for the human capital index we have 1.7% of skill-biased technological change per year and a substitution elasticity of -1.5 between low- and high-skilled labour. The estimation results in Table 1 suggest a standard deviation of skill-biased technological change of 0.6%. As a lower and upper margin for human capital growth in the past we then calculate the rise in the human capital index with 1.1% and 2.3% of skill-biased technological change, respectively. This results in a lower and upper bound for the annual growth in the human capital index of 1.1% and 2.2% for the period 1993-2002, respectively. This implies a different value for TFP growth in the past and the future. For the past, the TFP growth rate rises and falls to 0.9% and 0.1% for the lower and upper bound of the growth in the human capital index, respectively. For projected GDP growth in the future there are 2 effects. First, there is the effect on TFP, which is the projected effect from the past, a rise or fall of about 0.4%. Second, the expected growth in the human capital index changes. At the lower margin the future growth in the human capital

[56] The following recent quote of US Defence Secretary Donald Rumsfeld springs to the mind:' ... as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns - the ones we don't know we don't know.' Our sensitivity analysis does not consider the 'unknown unknowns'.

[57] Here we are mostly concerned with the sensitivity of the base projection with respect to alternative 'trend' developments in the past and future. In Jongen (2004a) we consider the impact of some alternative policy scenarios on the base projection.

index falls from 2.3% to 1.5%. At the upper margin, the growth in the human capital index rises from 2.3% to 3.2%. Taking into account both the effect on future TFP growth and the future growth in the human capital index, we expect future real GDP growth to lie between 3.4 and 3.9%. Note that a large part of the resulting higher or lower future growth in the human capital index is offset by the opposing change in projected TFP growth.

Next, we consider alternative developments for capital deepening in the past. Our preferred capital series has an average annual growth rate of 6.8% over the period 1993-2002. We have reliable data for real investment over this period. However, we have only limited knowledge of the depreciation of capital, and the level of the capital stock in any given year. This makes past capital growth relatively unreliable. However, given the drop in the user cost of capital it does seem likely that there was some capital deepening (*i.e.* a rise in the capital-output ratio). Let us then take as a lower margin that capital grew at the rate of output, 4.1%, over the period 1993-2002, and let us take the 'symmetric opposite' from our preferred series, 9.5% (=6.8% + (6.8-4.1)%), as the upper margin. How do these lower and higher capital growth rates in the past affect projected growth? Via TFP. With physical capital growth at the lower and upper margin, TFP growth would be 0.8% higher or lower, respectively. Following our base scenario methodology, this would imply that the future growth of real GDP could be 1.1% higher or lower, for the lower and upper margins respectively. Hence, changes in past growth in physical capital have a substantial impact on projected GDP growth. Note that because we assume this has no effect on future capital deepening, there is no offsetting effect on projected capital growth.

5.2. Sensitivity to alternative developments in the future

The growth in labour is expected to fall slightly, from about 0.16% over the period 1993-2002 to about 0.12% over the period 2002-2013. This is mostly due to a fall in the unemployment rate. As an alternative, consider the case where there would be no drop in unemployment.[58] Employment would then fall at an annual rate of -0.06%. This lowers projected output growth to 3.4% per year. However, we may also envisage a higher growth rate of employment due to *e.g.* a higher increase in the participation of the elderly than in the base projection for example.[59] Suppose that we take the symmetric opposite again, where employment would grow at 0.30% per year over the period 2002-2013. This would raise GDP growth to 3.8% over the period 2002-2013.

Regarding human capital, we considered alternative assumptions regarding skill-biased technological change above in the sensitivity analysis regarding developments in the past. Here we concern ourselves with alternative future developments in the share of high-skilled workers. Given the high recent enrolment rates in tertiary education and the projected outflow of relatively low educated workers from the workforce, it seems reasonable to expect a further rise in the share of high-skilled workers. Let us consider a scenario where the growth in the share of tertiary educated workers is 50% lower or higher than in the base scenario. This would result in annual growth in the human capital index of 2.0% and 2.5%, respectively.

58 Assuming no drop in the unemployment *rate* leads to almost the same quantitative results, the change in the gross number of participants is relatively small.

59 For a more elaborate analysis of the participation rates of the elderly in the future, see Jongen (2004a).

Table 4: **Sensitivity analysis projected annual growth in GDP per capita, growth rates in %, 2002-2013**

Growth in	Labor	Human Capital	Capital-output ratio	TFP	GDP p.c. growth
Slovenia					
base projection	0.1	2.3	1.1	0.5	3.6
alternative developments in the past					
lower human capital growth (-1 sd)	0.1	1.5	1.1	0.9	3.4
higher human capital growth (+1 sd)	0.1	3.2	1.1	0.1	3.9
lower physical capital growth (K/Y constant)	0.1	2.3	1.1	1.3	4.7
higher physical capital growth (K/Y 9.5%)	0.1	2.3	1.1	-0.3	2.4
alternative developments in the future					
no drop in unemployment	-0.1	2.3	1.1	0.5	3.4
higher participation	0.3	2.3	1.1	0.5	3.8
lower human cap. growth (growth in s_h -50%)	0.1	2.0	1.1	0.5	3.3
higher human cap. growth (growth in s_h +50%)	0.1	2.5	1.1	0.5	3.8
lower phys. cap. growth (K/Y constant)	0.1	2.3	0.0	0.5	3.1
higher phys. cap. growth (K/Y 2.1%)	0.1	2.3	2.1	0.5	4.0
lower TFP growth (-50%)	0.1	2.3	1.1	0.3	3.2
higher TFP growth (+50%)	0.1	2.3	1.1	0.8	3.9
EU-25					
Base projection	-	-	-	-	2.3
Lower projected growth	-	-	-	-	2.1
Higher projected growth	-	-	-	-	2.5

Note that the change in the growth in the human capital index is not that dramatic since it also captures the unaltered growth in skill-biased technological change. Annual output growth falls and rises to 3.3% and 3.8%, respectively.

Next, consider alternative future scenarios for capital growth. In the base projection we calculate a further capital deepening of 1.05% per year over the period 2002-2013. As an alternative, suppose there will be no further capital deepening or that the substantial capital deepening will continue to some extent into the future, 0.0% and 2.1% for the growth in $K(t)/Y(t)$, respectively. This would lower or increase projected output growth to 3.1% and 4.0%, respectively.

Finally, perhaps the hardest series to project is TFP growth. In the discussion of the base projection we argue that there are good reasons to expect TFP growth in the future to be either higher or lower than in the past. It is hard to put a reasonable margin on this, but suppose that we consider TFP growth to be 50% lower or higher, respectively. This would reduce or increase annual real GDP growth over the period 2002-2013 to 3.2% and 3.9%, respectively.

Table 4 gives an overview of the results from the sensitivity analysis of projected real GDP growth. For most alternative developments we find that the alternative growth rates move within the band from 3.0% to 4.0%. The notable exception being past physical capital growth, whose uncertain past growth rate cause future output growth to move within the band of 2.4% to 4.7%. A comparison with other studies on past capital growth in Slovenia suggests that, if anything, past capital growth is however more likely to have been lower than higher than our preferred series. Projected output growth would then be more likely to be higher than lower.

5.3. Comparison with other studies

We conclude the sensitivity analysis by briefly considering the projected growth rates of some other studies that deal with future GDP growth in Slovenia.

Projected growth is in line with 'Barro regression' projections for Slovenia

For an illustrative calculation regarding convergence to the EU (for more on this, see Section 6 below), the Economic Policy Committee (2003) of the EU suggests an annual growth rate for Slovenia of 3.7% from 2004 onwards.

Fisher *et al.* (1998a) suggest a per capita growth rate somewhere between 3.8% (using the 'Levine-Renelt' equation, see the paper for details) and 4.6% (using the 'Barro' equation, see the paper for details) from the mid-1990s onwards. Fisher *et al.* (1998a) come to these growth rates by superimposing the results from cross-country regressions on other countries (not enough data were available at the time for the transition countries) on the impact of variables like education, government expenditures and initial income on subsequent growth rates. In a closely related study, Fisher *et al.* (1998b) somewhat surprisingly come to higher growth rates of 4.6 and 5.3 for per capita growth. These growth rates apply to the period after the mid-1990s. Over the period 1995-2002 the actual per capita growth was 4.0%. Hence, the projection of Fisher *et al.* (1998a) comes surprisingly close. Hence, for this period at least the growth potential in Slovenia seems to be quite well summarised in initial GDP per capita and only a few other conditioning variables. Assuming no big changes in the conditioning variables since 1995, the higher per capita income in 2002 than in 1995 would imply a somewhat lower growth for the period after 2002, in line with our projection.

Following a similar procedure as Fisher *et al.* (1998a,b), but using new growth regressions (using *e.g.* relative income rather than absolute income as a dependent variable)[60], Crafts and Kaiser (2004) come to a projected annual growth rate in GDP per capita of 3.0% to 3.4%.[61] Crafts and Kaiser (2004) further argue that the projections of Fisher *et al.* (1998a,b) are too favourable, in part due to the use of absolute rather than relative income levels, and in part due to the omission of some institutional variables. As shown above, however, at least for the period 1995-2002 the projection of Fisher *et al.* (1998a) was quite accurate for Slovenia.

Finally, following again an essentially similar procedure as in Fisher *et al.* (1998a,b), but now superimposing parameters estimated from data on only Western European

[60] Furthermore, they also have the advantage of hindsight for the 1998-2003 period.

[61] Leaving out the 'outlier' of 1.3 in column (7) in Table 6 of Crafts and Kaiser (2004).

economies, Wagner and Hlouskova (2001) come to a growth rate in between 3.0 and 4.6% depending on the scenario used. They report a mean of the scenarios of 3.9%, but this seems to be driven to some extent by the (arbitrary) large share of relatively favourable scenarios.

To summarise, Fisher *et al.* (1998a) predicted per capita growth of around 4% for the period after 1995, which seems pretty accurate up to 2002. The approach of Fisher *et al.* (1998a) would also lead to a somewhat lower growth rate after 2002, as Slovenia has been catching up in income levels since 1995. Fisher *et al.* (1998b) seems too optimistic. Crafts and Kaiser (2004) predict somewhat slower growth after 2002, around 3.2%, whereas Wagner and Hlouskova (2001) predict somewhat higher growth (taking their reported mean of the scenarios) of 3.9%. Overall, we conclude that these studies using a 'Barro regression' type of approach to projected growth lead to a similar picture for future GDP growth in Slovenia as our 'growth accounting' approach, an annual per capita growth rate lying somewhere between 3% and 4%.

6. Catching up with the EU

Finally, we consider convergence with the EU-average (the EU-15 plus the 10 new member states that joined in the wave of 2004) in terms of GDP per capita. Again we focus on the period up to 2013. First, will 3.6% be enough to catch up with the EU average by 2013?[62] For this we will need to make a projection for the EU growth rate as well. Furthermore, if 3.6% is not enough, what would be the required growth rate for Slovenia to catch up by 2013?

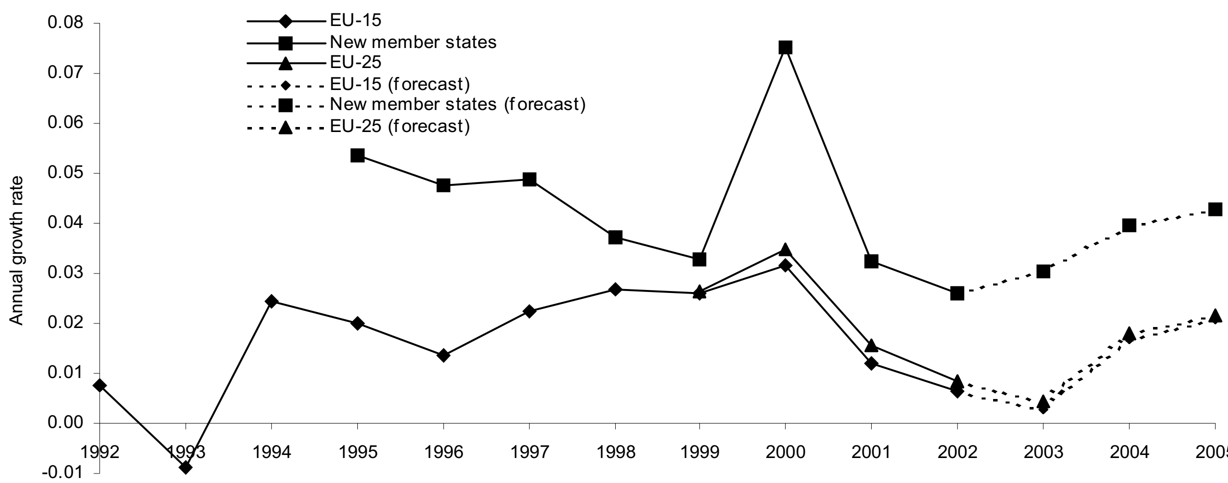
6.1. Base projection EU growth rate

Unfortunately, no official long-run projections or scenarios for real per capita GDP growth in the EU exist, at least not up to 2013. For some back-of-the-envelope calculations for the time it will take for CEECs to catch up with the EU-15, the EPC (2003) used a growth rate of 2.4%. This seems a bit too favourable, however, as we will see below.

We project an annual growth in GDP per capita in the EU-25 of 2.3% for the period 2002-2013

A detailed projection for the EU along the lines of the projection we made for Slovenia is beyond the scope of this paper. Instead, we will simply extrapolate past EU growth into the future. Figure 15 plots the recent growth rates of GDP per capita in the EU-15 (1992-2002), the 10 new member states that joined in the wave of 2004 (1995-2002), and the 'EU-25' (1999-2002). The data are taken from Eurostat. Figure 15 also gives the forecast for 2003-2005 from Eurostat (in February 2004). The average growth rate of the EU-15 was 1.7% from 1992 to 2002. The average growth rate of the new member states over the shorter period 1995-2002 was substantially higher, 4.4%. The main point of this graph, however, is that the growth rate of the EU-25 is mainly determined by the growth rate of the EU-15, due to its much larger population.[63]

Figure 15: **Recent growth rates in GDP per capita in the EU**

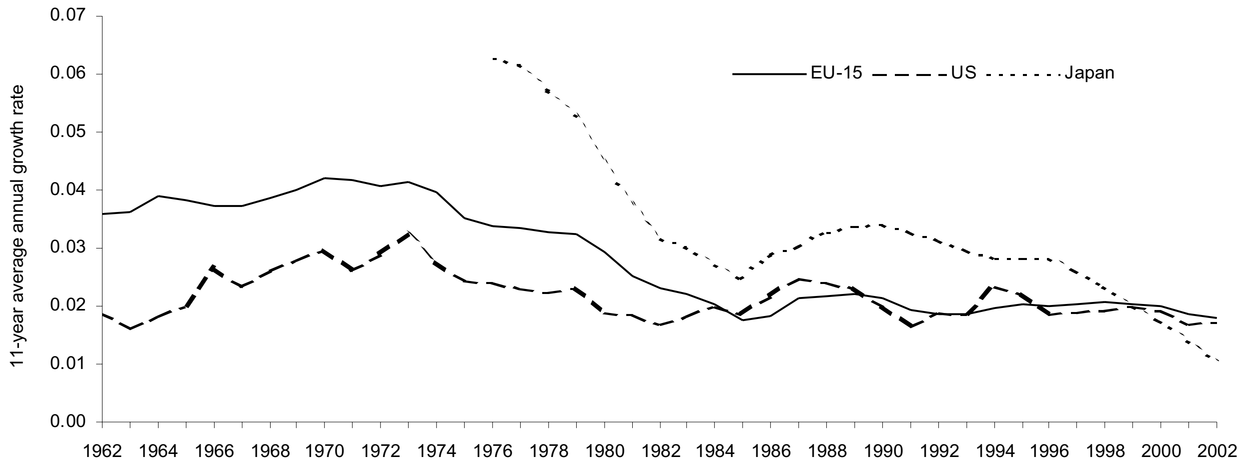


Source: Eurostat (01-02-2004), and own calculations.

[62] The projected change in the population is so small that we can take the projected percentage change in real GDP as the projected change in real GDP per capita for Slovenia.

[63] According to Eurostat on 01-01-2003 the population in the 10 new member states was about 74 million, compared to a population of about 380 million in the EU-15.

Figure 16: **11-year averages of per capita growth rates, selected OECD countries/regions**



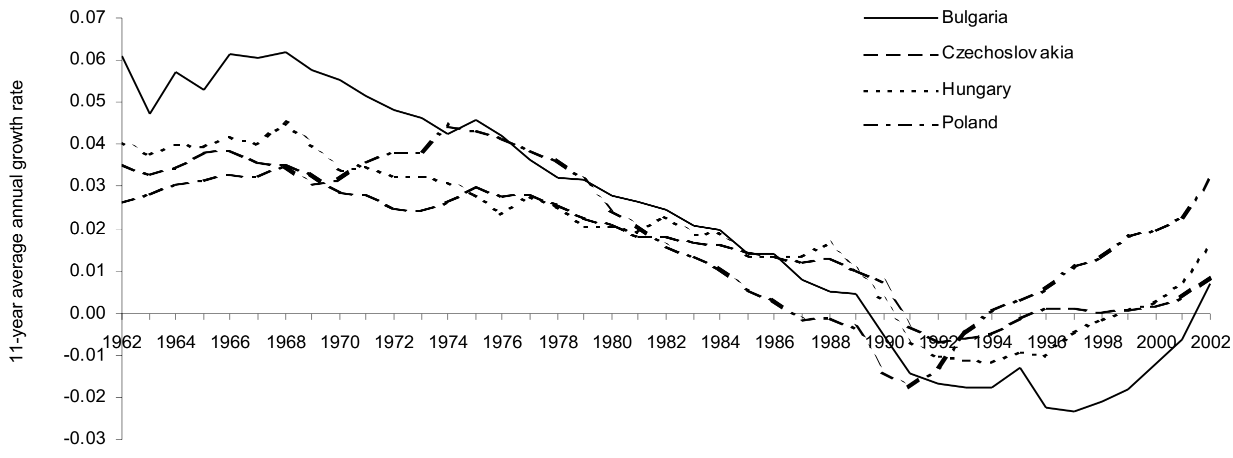
Source: Own calculations based on data by country from the Groningen Growth and Development Centre (2004). **Note**: The series for the EU-15 exclude data for Germany. We take the 'EU-14' as an indicator of the growth of real GDP over an 11-year period in the EU-15. '1962' is the average growth rate for the period 1951-1962, *etc.*

For an educated guess of growth in the EU-15 we have to take a look at longer data series. Figure 16 plots the 11-year averages for the EU-15, and the US and Japan for the period 1951-2002. We calculate 11-year averages because of the length of the interval we are interested in: 2003-2013. The value for a given 'year' denotes the average growth rate of that year and the 10 years preceding it (hence, 2002 gives the average growth rate for the period 1991-2002).

For the EU-15, and most other countries (see the US and Japan series), there appears to be a structural break in the growth rate around the beginning of the 1970s (the 'productivity slowdown'). Selecting 1973 as the break point, we calculate an average growth rate of 2.1% over the period 1993-2002. The maximum 11-year average over the period 1973-2002 was 3.4%, which occurred at the beginning of the period, the minimum is 1.8%, which occurs in some subsequent periods.

Figure 17 plots 11-year averages for selected Eastern and Central European countries (we only include countries that have long data series). Figure 17 shows

Figure 17: **11-year averages of per capita growth rates, selected CEEC countries/regions**



Source: Own calculations based on data by country from the Groningen Growth and Development Centre (2004). **Note**: The series for Czechoslovakia are for the sum of the Czech and Slovak Republic before and after the split. '1962' is the average growth rate for the period 1951-1962, *etc.*

the dramatic decline in the per capita growth rate of real GDP in these countries in the late 1980s/early 1990s[64], and the subsequent rise. Figure 17 indicates that the growth in the CEECs was more volatile than in the EU-15.

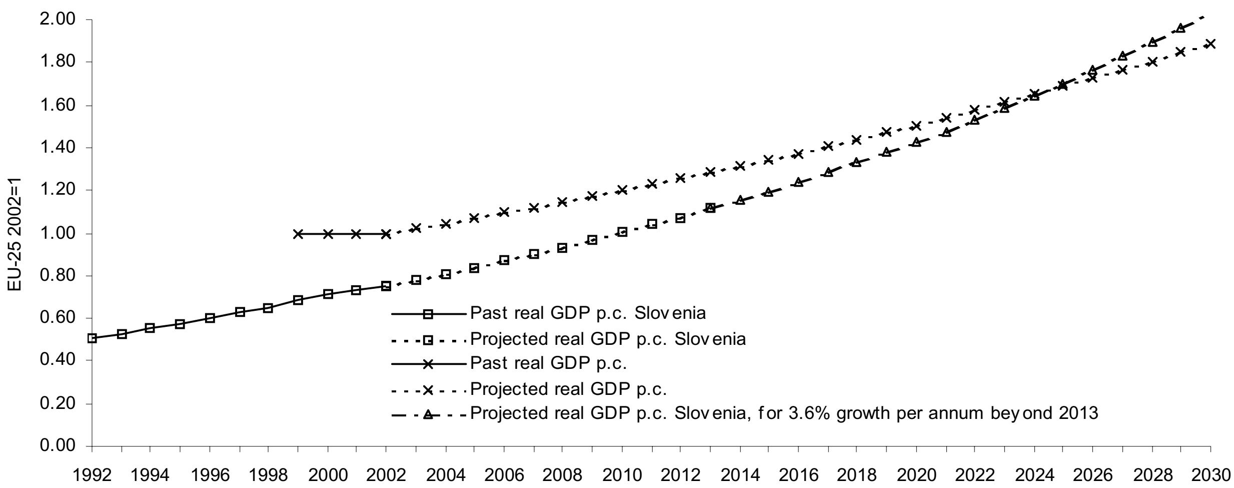
Suppose we take the populations of the EU-15 and the 10 new member states in 2002 as weights (380 and 74 million inhabitants, respectively). Suppose that GDP per capita in the EU-15 continues to grow at 2.1% as it did in the period 1973-2002, and suppose that GDP per capita in the 10 new member states grows on average at the same pace as our base projection for Slovenia, 3.6%. We then come to a base projection for future annual growth in GDP per capita in the EU of 2.3%.[65]

6.2. Convergence?

If GDP per capita in the EU grows at 2.3% per year over the period 2002-2013, what would be the required growth rate for GDP per capita in Slovenia over this period in order to catch up with the EU average?

In 2002 Slovenia was at 75.5% of average real GDP per capita in the EU-25 (in purchasing power parity (PPP) terms).[66] Solving for g^* in $(1+g^*)$^11*0.755 = 1 gives $g^* = 0.026$. Hence, to catch up with the EU in terms of GDP per capita by

Figure 18: **Convergence with the EU?**



Source: Own calculations.

[64] Figure 17 also suggests that the Central and Eastern European countries had on average similar or even higher growth rates than the OECD countries of Figure 16 until the 1980s. However, the old data are not very reliable. Informal sources suggest, for example, that the inflation rate was understated so as to overstate the real growth rate.

[65] For comparison, CPB recently published four scenarios for the future of Europe, see Lejour (2003) and De Mooij and Tang (2003). They distinguish the following scenario's: 'global economy', 'strong Europe', 'regional communities' and 'transatlantic market'. For the 2002-2013 period they find the following average growth rates in real GDP per capita for the EU-15 for these 4 scenarios, respectively: 2.2%, 1.4%, 1.1% and 2.1%. For what they define as Central and Eastern Europe (Poland, Hungary, Czech Republic, Slovakia, Slovenia, Bulgaria, Romania) they find the following real GDP per capita growth rates for the 4 scenarios, respectively: 3.5%, 3.6%, 2.5% and 3.0% (source: personal communication). Using the growth in 'Central and Eastern Europe' as a proxy for the growth in the 10 new member states and assuming that the relative population remains the same as in 2002 (EU-15 380 million, 10 new member states 74 million) we find for the EU-25 the following respective growth rates in GDP per capita over the 2002-2013 period: 2.5%, 1.7%, 1.3% and 2.3%. From this I take it that a value of around 2.3% is not out of line with these scenarios.

[66] Source: IMAD.

To catch up with EU-25 average GDP per capita by 2013, average real GDP growth in Slovenia has to be around 4.9% over the period 2002-2013

Extrapolating our base projection beyond 2013, for an annual growth rate of 3.6% beyond 2013 we find that it might take up to 2025 before Slovenia catches up with the EU-25 average

2013, real GDP per capita in Slovenia has to grow 2.6% faster than in the EU over the period 2002-2013. With a projected growth rate of 2.3% for the EU, this implies that Slovenian per capita growth would have to be 4.9%, 1.3% higher than our base projection.

As an exercise, suppose that we extrapolate the growth in Slovenian and EU real GDP per capita growth of 3.6% and 2.3% beyond 2013, then it would take up to around 2025 before Slovenia catches up with the EU average, see Figure 18. Note that this is presumably still too favourable as we may not expect any further increase in the capital-output ratio beyond 2013, for example. Without capital deepening beyond then, it would take until 2032 before Slovenia would catch up with the EU average.[67]

As an exercise we may further consider the change in the inputs required in Slovenia to increase real GDP growth by this 1.3% relative to the base scenario. The change required per single input is as follows. TFP growth would have to be 1.3%*0.7 = 0.9% higher than in the base projection.[68] Alternatively, the growth in labour or the human capital index would have to be 1.3% higher. Finally, the capital-output ratio would have to be 1.3%*0.7/0.3 = 3.0% higher over the period 2002-2013 to catch up with the EU-25 average in 2013.

6.3. Uncertainty regarding future EU growth

As for Slovenia, we also want to consider some reasonable alternative future scenarios for per capita GDP growth in the EU. The standard deviation of the 11-year averages series for the growth rate of the EU-15 over the period 1973-2002 is 0.13.[69] Supposing that the growth rates of the new member states will remain more volatile[70], a reasonable lower and upper margin for future per capita GDP growth in the EU seems to be 2.1% and 2.5%, respectively. Slovenian GDP growth would then have to be correspondingly lower and higher to catch up with the EU by 2013.

[67] We might also not expect any further labour growth after 2013, but the same probably holds for the EU.

[68] Note that the impact of higher TFP growth on GDP growth gets an additional boost from higher capital growth, to keep the capital-output ratio constant.

[69] In this calculation the early years and the final years will be 'undersampled', as 1973 and 2002 are included only once for example. The standard deviation of the *annual* growth rates is 1.4 over the 1973-2002 period, 1.8 over the 1973-1983 period and 1.2 over the 1992-2002 period (the 'undersampled' periods). We assume that the 'undersampling' of both periods cancels out. Further, with the standard deviation falling over time, we are already taking a relatively wide band.

[70] And assuming that this raises the volatility of the EU growth rate, *i.e.* deviations in growth rates in the EU-15 and the 10 new member states do not move in opposite directions, which seems increasingly likely with the increased trade relations between the EU-15 and the new member states.

7. Concluding remarks

The future for growth in real GDP per capita in Slovenia still looks bright. Over the period 1993-2002 Slovenian GDP per capita grew at the brisk pace of 4.1% per year. The main driving forces appear to have been physical and human capital accumulation. For the future, we project somewhat slower growth, around 3.6% when using our preferred series. Human capital accumulation is projected to pick up but this is dominated by lower projected physical capital deepening.

3.6% growth in real GDP per capita in Slovenia will not be enough to catch up with average real GDP per capita in the EU by 2013. To catch up with the EU average by 2013, growth in GDP per capita in Slovenia would have to be about 4.9% per year. Given the base projection of 3.6%, this seems a rather big leap. However, in Jongen (2004a) we indicate that there is still a lot of room for improvement relative to the EU, in particular in TFP, which leaves much room for still higher growth rates.

We conclude with a cautionary note. The preceding analysis builds on short data series of an economy that has witnessed substantial structural changes over the past decade, and which can be expected to witness more of them in the future. Hence, our findings from the past and projections for the future should be interpreted with perhaps more than the usual levels of care.

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Egbert L. W. Jongen*

Future GDP Growth in Slovenia: Looking for Room for Improvement

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* CPB Netherlands Bureau for Economic Policy Analysis and Institute for Economic Research. This paper was written while I was visiting IMAD. I gratefully acknowledge their hospitality.

Contents

Povzetek

Glede na projekcijo iz naše prve, vsebinsko sorodne študije (glej Jongen, 2004a), utegne trajati še precej časa, preden bo Slovenija dosegla povprečno raven realnega bruto domačega proizvoda na prebivalca v EU. V tej študiji preučujemo, kakšne so še realne možnosti za pospešitev rasti BDP v obdobju do leta 2013. Analiza temelji na primerjavi rezultatov mednarodnih raziskav glede učinkov posameznih inputov na gospodarsko rast v letu 2002 v Sloveniji, v državah EU-15, v desetih novih članicah EU in v ZDA.

Ugotavljamo, da se stopnja zaposlenosti v Sloveniji giblje blizu povprečja EU-15 in nekoliko nad povprečjem držav novink. Vendar je v tem povprečju skrita relativno nizka stopnja zaposlenosti starejših delavcev (55–64 let) v Sloveniji v primerjavi s povprečjem EU-15 in EU-25.

Skoraj na ravni povprečja držav EU-15 je v Sloveniji tudi povprečno število let šolanja. Pri tem opazneje izstopa le nizek delež posameznikov s končano terciarno izobrazbo v primerjavi z EU-15, ki pa je vendarle višji kot v drugih novih članicah, za katere imamo podatke.

Tudi delež fizičnega kapitala v vrednosti proizvodnje v Sloveniji le malo zaostaja za povprečjem EU-15, vendar pa je še nekaj prostora za nadaljnje kapitalsko poglabljanje, saj so realne obrestne mere v Sloveniji še vedno relativno visoke.

V nadaljevanju obravnavamo razlike v skupni faktorski produktivnosti (TFP). V letu 2002 je realni BDP na prebivalca po kupni moči v Sloveniji znašal približno 76% povprečja držav EU-25. Glede na to, da so prispevki dela, človeškega in fizičnega kapitala blizu povprečja v EU, ne preseneča, da je vrzel v skupni faktorski produktivnosti zelo podobna vrzeli v BDP na prebivalca. Nadalje ugotavljamo, da je bila v Sloveniji rast skupne faktorske produktivnosti v obdobju 1990–2002, relativno glede na povprečno skupno faktorsko produktivnost v EU, zgolj 1%, v primerjavi z njeno 9-odstotno povprečno rastjo v desetih novih članicah. Vendar pa je v primerjavi s povprečjem desetih držav novink Slovenija mnogo bližje ciljni ravni skupne faktorske produktivnosti. Ob tem naj še opozorimo, da je pri interpretaciji tovrstnih mednarodnih primerjav potrebna ustrezna mera previdnosti. Analizo omejuje dostopnost in primerljivost podatkov, odvisna pa je tudi od izbrane produkcijske funkcije. Razen tega primerjamo države novinke v različnih fazah tranzicije, pri čemer so še zlasti lahko problematične medčasovne primerjave.

Naslednji sklop je namenjen analizi dejavnikov, ki so lahko vzrok za razlike v skupni faktorski produktivnosti v Sloveniji in v EU (ter v ZDA):

(1) Najprej obravnavamo dejavnike, ki označujejo stopnjo izpostavljenosti novim tehnologijam (pri čemer upoštevamo širšo definicijo tehnologije, ki vključuje tudi institucionalno ureditev). Tako delež izdatkov za raziskovalno-razvojno dejavnost v BDP močno presega povprečje drugih držav novih članic, vendar je še vedno nekoliko pod povprečjem EU-15 in daleč za ZDA. Nekje vmes med državami novinkami in 15 starimi članicami je Slovenija tudi po nekaterih indikatorjih kakovosti R&R. Mednarodna trgovina in neposredne tuje investicije pogosto veljajo za spodbujevalce konvergence skupne faktorske produktivnosti. Delež slovenskega izvoza in uvoza presega povprečje EU, vendar to drži za večino malih držav v EU. Slovenija pa izrazito izstopa glede

stanja vhodnih (in v manjši meri izhodnih) neposrednih tujih investicij, kjer zelo zaostaja za povprečjem EU-15 in še bolj za povprečjem drugih novink.

(2) Nadaljujemo z dejavniki, ki odražajo absorpcijsko sposobnost za nove tehnologije. Osredotočili smo se zlasti na ureditev, ki se nanaša na odpiranje novih delovnih mest in tokove zaposlenih. Ugotavljamo, da je varnost zaposlitve v Sloveniji relativno velika in da je ustanovitev podjetja v Sloveniji v primerjavi z državami EU-15 in ostalimi novinkami dokaj zamudna, vendar se tokovi odpiranja in zapiranja delovnih mest v Sloveniji kljub temu ne razlikujejo bistveno od držav EU-15 in držav novink, za katere imamo podatke. Nekoliko nizki pa so glede na tokove delovnih mest tokovi zaposlenih.

(3) Nazadnje obravnavamo še nekatere dodatne indikatorje, ki lahko vplivajo na učinkovitost proizvodnje. Tako je uveljavitev pogodb v Sloveniji zelo zamudna, možnosti najemanja posojil pa so omejene, kar je lahko vplivalo na manjše število učinkovito izvedenih poslov v Sloveniji. Delež javnih izdatkov v BDP je blizu povprečja držav EU (čeprav podatki verjetno niso povsem primerljivi), višina državnih pomoči pa je še vedno precej nad povprečjem EU-15 (za druge države novinke ni podatkov).

Študijo zaključujemo z izračunom potencialne gospodarske rasti, če bi izpolnili predstavljene preostale možnosti za pospešitev rasti. Konkretno ugotavljamo, kakšen bi lahko bil učinek spremembe v predvideni rasti vsakega od inputov na povprečno stopnjo rasti BDP na prebivalca v obdobju 2001- 2013. Glede na osnovno projekcijo (Jongen, 2004) vidimo, da bi lahko z zaprtjem vrzeli v prispevkih dela, človeškega in fizičnega kapitala povečali stopnjo rasti za nekoliko manj kot eno odstotno točko. Po izračunu iz predhodne študije (Jongen, 2004) pa bi morala biti stopnja gospodarske rasti za 1.3 odstotne točke višja kot v osnovni projekciji, da bi slovenski BDP na prebivalca do leta 2013 dosegel povprečje EU-25. Skupna faktorska produktivnost bi torej morala rasti hitreje kot v državah EU-25. K sreči ima Slovenija še dovolj prostora za relativno rast skupne faktorske produktivnosti. Nakazali smo, kateri bi lahko bili dejavniki, ki bi prispevali k višji rasti skupne faktorske produktivnosti, čeprav je njihove učinke težko kvantitativno oceniti.

Ključne besede: mednarodna primerjava, računovodstvo gospodarske rasti, relativna skupna faktorska produktivnost, potencial gospodarske rasti

Summary

In a companion paper we project it may still take a long time before Slovenia catches up with the EU average in terms of real GDP per capita (see Jongen, 2004a). In this paper we consider where there is still ‘room for improvement’ in terms of GDP growth for the coming decade. Specifically, we compare various indices for inputs to production in 2002 for Slovenia with those for the EU-15, the 10 new member states that joined in the wave of 2004, and the US.

The employment rate in Slovenia is quite close to the EU-15 average, and somewhat above the average of the accession countries. However, hiding behind the average is a relatively low employment rate of elderly workers (55-64) in Slovenia compared to the EU average.

Average years of schooling in Slovenia is also quite close to the EU-15 average. Here the notable exception is the share of individuals who have finished tertiary education, which is quite low compared to the EU-15 average, although higher than in the other accession countries for which we have data.

For the capital-output ratio in Slovenia we again find that it is quite close to the EU-15 average. There is still some room left for further capital deepening though, with real interest rates still above those in the EU-15.

We next consider differences in the (residual) ‘total factor productivity’ (TFP). In 2002 Slovenia was at about 76% of real GDP per capita (in PPP) of the EU-25 average. Given that the labour, human capital and physical capital inputs are quite similar to the EU average, it should come as no surprise that we find that the gap in TFP is very close to the gap in GDP per capita. We further find that the growth in TFP in Slovenia relative to average TFP in the EU was only 1% over the 1990-2002 period, compared to around 9% for the 10 new member states on average. Note, however, that Slovenia started much closer to the TFP frontier than most of the other accession countries and further note that these international comparisons should be interpreted with the appropriate care. The analysis is limited by data availability and comparability, and depends on the functional form chosen for the production function. Further, in particular in the comparison across time we compare accession countries that are in different stages of the transition process.

We then turn to factors that can ‘explain’ the difference in TFP in Slovenia with the EU average (and the US):

(1) First, we consider factors that indicate the level of exposure to new technologies (broadly defined, so as to include institutions). The share of research and development (R&D) in GDP is much higher than the other new member states on average, but still somewhat below the EU-15 average. There is a large gap vis-à-vis the US. Also regarding some indicators of the quality of R&D, Slovenia takes an intermediate position between the EU-15 and the new member states. Trade and foreign direct investment (FDI) are often believed to stimulate TFP convergence. We find that exports and imports are above the EU average. However, this holds for most small countries in the EU. Where Slovenia stands out is in inward (and to a lesser extent outward) FDI stock. Slovenia is far below the EU-15 average, and even further behind the average for the other new member states.

(2) Next, we consider factors that indicate the absorption capacity for new technologies. Here we mainly look at the institutions related to job and worker flows. Although employment protection legislation was relatively strict and it is relatively time consuming to start up a business relative to the EU-15 and the other new member states, job flows do not appear out of line when compared to the EU-15 and those new member states for which we have data. Yet worker flows seem a bit low compared to job flows.

(3) We conclude the list of factors that may explain the differences in TFP with some factors that may affect the efficiency of production in general. It appears to be very time consuming to enforce a contract in Slovenia, whereas the use of credit facilities is limited. This may have limited the number of efficient transactions in Slovenia. Government expenditures as a share of GDP are quite close to the EU average, whereas state aid is still quite far above the EU-15 average (no data were available for the other new member states).

We conclude with a calculation of the growth potential based on the remaining 'rooms for improvement'. Specifically, we consider what the impact is on the average growth rate of GDP per capita over the 2002-2013 period of closing one particular 'gap' in the inputs. Relative to the base projection of Jongen (2004) we find that the remaining gaps in labour, human capital and physical capital input may raise the growth rate by somewhat less than one percentage point. In Jongen (2004) we calculate that the growth rate in Slovenia would have to be around 1.3 percentage points higher than in the base projection to catch up with the EU-25 average in terms of GDP per capita by 2013. For this, TFP will have to grow faster than in the EU-25. Fortunately, there is still a lot of room left regarding relative TFP growth and we have tried to indicate some factors that may contribute to higher TFP growth, although their impact is typically hard to quantify.

Keywords: international comparison, growth accounting, relative total factor productivity, growth potential

1. Introduction[1]

Over the period 1993-2002 real GDP per capita in Slovenia grew at a brisk pace of 4.1% per year.[2] In Jongen (2004)[3] we project that the average annual growth in real GDP per capita over the period 2002-2013 is likely to be somewhat lower, about 3.6%. Although this growth rate would still be impressive relative to the EU average, in Jongen (2004) we project that it might still take decades before Slovenia catches up with the EU average of real GDP per capita. In this paper we consider where there is still 'room for improvement' regarding future GDP growth.[4] Specifically, we compare various indicators for inputs to production for Slovenia with those for the EU-15, the 10 new member states that joined in May 2004, and the US. Most data are for 2002.[5] For the EU we also consider the gap as against the Lisbon strategy target if a quantitative target is formulated (which typically represents a move towards the US level, hence the inclusion of the US in the international comparison).[6] For each indicator we further quantify how much of the 'gap' is closed in the base projection of Jongen (2004), how much is left, and how much additional per capita growth would result if the 'gap' were to disappear over the period 2002-2013.[7]

The paper has the following outline. In Section 2 we start by searching for room for improvement regarding labour participation. Sections 3 and 4 then consider the room left for further human and physical capital deepening, respectively. Using cross-country growth accounting in Section 5 we next try to quantify how much of the differences in GDP per capita are left after controlling for differences in labour participation, human capital and physical capital, *i.e.* the gap in 'total factor productivity'. Section 6 then considers some factors that may explain part of the gap in total factor productivity, while Section 7 considers the impact of closing one of the gaps on growth in GDP per capita over the coming decade. Section 8 concludes.

[1] CPB Netherlands Bureau for Economic Policy Analysis (CPB) and Institute for Economic Research (IER). Address: CPB Netherlands Bureau for Economic Policy Analysis, Van Stolkweg 14, P.O. Box 80510, 2508 GM The Hague, The Netherlands. Phone +31-70-3383380, fax +31-70-3383350, e-mail: jongen@cpb.nl. I am grateful to Ivo Lavrač, Boris Majcen, Janez Šušteršič and in particular Janez Kušar for comments and suggestions. Any remaining errors are my own. Furthermore, the opinions expressed in this paper are my own and do not necessarily coincide with the opinions of the CPB, IER or IMAD. All data and graphs can be found online at: www.gov.si/umar. This paper serves as a background paper for the new strategy for the government to be implemented in 2006. For a preliminary draft of the new strategy, see: www.gov.si/umar. For past strategies, see Potočnik *et al.* (1995, 1998).

[2] Following a period of contraction over the period 1987-1992, resulting in a cumulated drop in real GDP of about 20 percent in 1992 relative to 1986 (see Jongen, 2004).

[3] Included in this volume.

[4] At the end of 2003 the Slovenian 'Ministry of the Economy' published 'Benchmarking Slovenia 2003' which deals partly with similar issues. However, we use more recent data and also give data on some other topics. Furthermore, in addition we try to quantify the impact of changes in the indicators on projected GDP growth.

[5] For most variables 2002 is the most recent year for which we have internationally comparable data.

[6] See Economic Policy Committee (2003, Annex 2) for an overview of the quantitative targets of the Lisbon strategy.

[7] Whether or not it makes sense to close one of the perceived gaps and, perhaps more importantly, *how* to close the gap is still beyond the scope of this paper. Indeed, although dramatic increases in *e.g.* investment in human capital, physical capital and research and development are likely to generate high per capita growth rates, at least in the short to medium run, this may have rather detrimental effects on consumption during this period which, at the end of the day, is what matters for the well-being of the population. Indeed, to assess whether or not closing a particular 'gap' is believed to be welfare enhancing or not one has to consider the underlying market failures explicitly and start from there to consider what is the most appropriate policy response, if any, to reduce the failure. Furthermore, one would then also have to move beyond the average/representative agent analysis presented here for both efficiency and equity reasons as a large part of the policy changes will have a different impact across the population.

2. Labour participation

We first consider the room left regarding labour participation. Table 1 gives an overview of the most relevant indicators for 2002. Data are taken from Eurostat. All comparison tables have the same format: we first give the indicator for Slovenia, followed by the EU-15 countries, the other new member states (that joined in May 2004), the average for the EU-15, the new member states and the 'EU-25' and, finally, also for the US. However, in Table 1 we already make an exception as we do not have comparable data for the US on most variables in Table 1.[8]

Table 1: **Activity, employment and unemployment rates, 2002, in %**[1]

	Activity rate	Employ-ment rate	Share part-time	Female employ-ment rate	Share of part-time females[2]	55-64 employ-ment rate[3]	Unemploy-ment rate	Share of long-term unemploy-ed
Slovenia	68	63	6	59	8	25	6.0	56
Austria	73	69	20	63	38	30	4.3	19
Belgium	65	60	19	51	37	27	7.3	49
Denmark	80	76	20	72	30	58	4.5	19
Finland	75	68	13	66	18	48	9.1	25
France	69	63	16	57	29	35	8.8	31
Germany	72	65	21	59	-	39	8.6	47
Greece	63	57	5	43	8	40	10.0	51
Ireland	68	65	17	55	30	48	4.4	30
Italy	61	56	9	42	17	29	9.0	59
Luxembourg	66	64	11	52	25	28	2.8	27
Netherlands	77	74	44	66	73	42	2.7	26
Portugal	72	68	11	61	16	51	5.1	34
Spain	66	58	8	44	17	40	11.3	34
Sweden	78	74	22	72	33	68	4.9	20
United Kingdom	76	72	25	65	44	54	5.1	22
Cyprus	71	69	-	59	-	49	3.8	21
Czech Republic	71	65	5	57	8	41	7.3	50
Estonia	69	62	8	58	11	52	9.1	52
Hungary	60	57	4	50	5	27	5.6	44
Latvia	69	60	-	57	-	42	12.8	45
Lithuania	70	60	-	57	-	42	13.1	54
Malta	59	55	8	34	18	30	7.4	43
Poland	65	52	11	46	13	26	19.9	55
Slovak Republic	70	57	2	51	3	23	18.6	65
EU-15	70	64	18	56	34	40	7.7	39
New member states	66	56	8	50	10	30	14.8	55
EU-25	69	63	17	55	30	39	8.9	43

Notes:
[1] Source: Eurostat (30-04-2004). The numbers are for individuals aged 15-64.
[2] Share of part-time female employees in total female employment.
[3] Employment rate of individuals aged 55 to 64.

[8] The US statistics that are available typically cover a different age group.

The first column in Table 1 gives the so-called activity rate, the number of employed and unemployed (actively looking for a job *etc.*) relative to the population aged 15-64. The activity rate in Slovenia is very close to the EU-15 average, which holds for most new member states (Malta and Hungary being the notable exceptions).

The average employment rate is close to the EU average. The employment rate of individuals aged 55-64 is very low compared to the EU average

Turning to the employment rate, Slovenia is again very close to the EU-15 average. This is not the case for the 'average' new member state, which reflects the relatively low unemployment rate in Slovenia relative to the other new members states (see below). Furthermore, Table 1 gives the employment rate in *persons*. This may actually understate the level of participation in employment in Slovenia relative to the EU-15, as part-time employment is relatively underdeveloped in Slovenia, see column 3.[9]

However, the average employment rate hides some noticeable differences across particular groups. On the one hand, female participation rates are relatively high (see column 4), in particular when one realises that again part-time employment is less common among Slovenian women than among women in the EU-15 (see column 5).[10] On the other hand, column 6 shows a more worrisome picture regarding the participation of the elderly. Of individuals aged 55-64, only 25% is (formally) employed in Slovenia as opposed to 40 percent on average in the EU-15. Also compared to the other new member states Slovenia does relatively poorly in terms of the participation of the elderly, leaving behind only the Slovak Republic. Unsurprisingly, the gap vis-à-vis the US is then enormous which, according to the Bureau of Labor Statistics[11], was 60% in 2002. Note that in the EU-15 Sweden does even better, with an employment rate of older workers of 68%. According to the United Nations, the 'elderly dependency ratio' (individuals aged 65+ to individuals 15-64) in Slovenia will increase from 0.20 in 2000 to 0.38 in 2025, and to 0.64 in 2050.[12] This puts Slovenia amongst countries with the steepest rise in the 'elderly dependency ratio' in the EU, making the issue of higher participation rates of the elderly all the more pressing.

We conclude with a look at unemployment. The unemployment rate was somewhat below the EU-15 average in 2002, and substantially below the average of the new member states. Insofar as the 'natural' unemployment rate in Slovenia is not below the average of the EU-15 countries[13], there seems to be little room for improvement left for reducing unemployment. However, the ageing of the working age population may cause a further reduction in unemployment as older workers have lower unemployment rates.[14] Turning to the last column we do note, however, that the duration of unemployment is relatively long in Slovenia given the high share of long-term unemployed (>1 year unemployed) in total unemployment. This can be seen as an indication that worker flows may be regarded as relatively low in Slovenia in general (see also Section 6.3 below).

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[9] This is one of the main reasons why Slovenian employees appear to work much more hours on average than citizen in the EU on average (see also Section 5 below).

[10] Table 1 further suggests that the employment rate of women is on average lower in the new member states than in the EU-15, but this may partly reflect a difference in formal and informal participation rates between the new member states and the EU-15.

[11] Source: www.stats.bls.org.

[12] Source: www.un.org. The numbers refer to the 'medium variant' of the demographic projection.

[13] The 'natural' unemployment rate in Slovenia may be lower due to a less favourable welfare state, at least for individuals who do not qualify for early retirement yet, but this may be expected to change as GDP per capita moves closer to the EU-15 average.

[14] Provided that the adverse effects of the rising tax burden of the ageing population do not dominate the demographic composition effect on the average unemployment rate.

Another issue regarding the room for further employment growth is migration. Over the past decade net migration has been limited.[15] However, if we believe that Slovenia will do well in the future relative to, for example, other former Yugoslav republics, then it may attract more immigrants in the future (and perhaps see fewer people leave), all the more so when the ageing of the population will drive up the wages of non-tradables (although the more dramatic changes in the dependency ratio will happen after 2013). However, even now there are big differences and we do not see big migration flows. Furthermore, for higher migration to have a positive effect on GDP per capita growth immigrants (emigrants) would need to have an above (below) average employment probability and higher (lower) than average education (or a higher (lower) average propensity to save). We do not see a big role for migration in the coming decade in the growth of GDP per capita.

Overall, we find that the biggest room for improvement regarding labour participation seems to be the participation of the elderly. We consider the additional growth potential of this residual 'participation gap' in Section 7 below.

[15] According to the Yearbook of the Statistical Office of the Republic of Slovenia (2003) the net migration of foreigners was about 3,000 persons in 2002, compared to a population of about 2 million.

3. Human capital

Next we consider indicators related to the average human capital of workers, see Table 2. In the first column we have public expenditure on education as a percentage of GDP (the latest comparable data for Slovenia is for 1999). This gives us an indication of the public 'investment flow' into human capital. Slovenia does better than the EU-15 average and the average of the new member states in this respect.

Table 2: **Indicators for human capital**

	Public exp. on educ. as % of GDP[1]	Average years of schooling[2]	Individuals with tertiary education (25-64), in %[3]	Individuals with tertiary education (25-34), in %[4]	Gross enrolment in tertiary education, in %[5]	Lifelong learning, in %[6]
	1999	2002	2001	2001	2000/2001	2002
Slovenia	5.6	11.6	17	20	61	9.1
Austria	5.9	12.4	14	14	58	7.5
Belgium	-	11.1	28	38	58	6.5
Denmark	8.1	13.0	27	29	59	18.4
Finland	6.3	11.4	32	38	-	18.9
France	5.9	10.6	23	34	54	2.7
Germany	4.6	13.0	23	22	-	5.8
Greece	3.6	10.2	18	24	63	1.2
Ireland	4.6	10.6	36	48	48	7.7
Italy	4.8	9.7	10	12	50	4.6
Luxembourg	-	-	-	-	-	-
Netherlands	4.8	11.9	23	27	55	16.4
Portugal	5.7	7.2	9	14	50	2.9
Spain	4.5	9.2	24	36	59	5
Sweden	7.5	11.7	32	37	70	18.4
United Kingdom	4.6	12.0	26	29	60	22.3
Cyprus	5.7	-	-	-	22	3.7
Czech Republic	4.1	-	11	11	30	5.9
Estonia	6.1	-	-	-	58	5.2
Hungary	4.7	-	14	15	40	3.2
Latvia	5.8	-	-	-	63	8.2
Lithuania	6.1	-	-	-	52	3.3
Malta	4.8	-	-	-	25	4.4
Poland	4.9	-	12	15	56	4.3
Slovak Republic	4.4	-	11	12	30	9.0
EU-15	5.0	11.1	22	26	56	8.6
New member states	4.9	-	-	-	48	4.9
EU-25	5.0	-	-	-	54	8.0
United States	4.9	13.3[7]	37	39	73	-

Notes:
[1] Public expenditure on education as a percentage of GDP. Source: Eurostat (30-09-2004) for all countries except Slovenia, for which we use Hanzek and Gregorcic (2002).
[2] Source: Commission of the European Communities (2003) for all countries except Slovenia, for which we use internal calculations from IMAD.
[3] Source: OECD (2003a), except for Slovenia for which we use internal data from IMAD (from the census 2002).
[4] Source: OECD (2003a), except for Slovenia for which we use internal data from IMAD (from the census 2002).
[5] Gross enrolment of individuals in tertiary education up to 5 years after finishing secondary education. Source: Unesco at www.un.org (30-04-2004) except for Slovenia, for which we use internal data from IMAD.
[6] Share of workers participating in some form of training or education in the 4 weeks before surveyed. Source: Eurostat (30-04-2004).
[7] Own lineair extrapolation using data from Comission of the European Communities (2003), using the average annual growth in average years of schooling in the US over the period 1980-1995.

Slovenia is above the EU-15 average in terms of average years of schooling, the share of individuals with tertiary education is below the EU-15 average

However, perhaps more informative than the flow of public education expenditure in any given year is the stock variable 'average years of schooling'.[16] Slovenia again appears to be somewhat above average relative to the EU-15 countries on this variable. Unfortunately, we do not have reliable data for the other new member states on the average years of schooling.[17]

On average, Slovenia appears to be somewhat above the EU-15 average in terms of education, but again there are marked differences when we move beyond the average. Over the relevant past, Slovenia has always had relatively high enrolment levels in primary and secondary education. This shows for example, in the stock of individuals with at least a secondary education. According to Eurostat (30-04-2004), in 2002 the percentage of individuals aged 25-64 with at least a secondary education was 64.6% in the EU-15, whereas in Slovenia it was 76.8%. Where Slovenia lags behind is in tertiary education.[18] Column 3 of Table 2 gives the share of individuals aged 25-64 who have finished tertiary education. In 2001 the share was 17% in Slovenia compared to 22% in the EU-15 and 37% in the US. For the new member states that are also a member of the OECD we also have comparable tertiary education data. Compared to the new member states for which we have data Slovenia appears to do relatively well.

However, the average for the age group 25-64 is a slow moving variable. Column 4 shows that the share of individuals with a tertiary education is higher for individuals aged 25-34 than for individuals aged 25-64 in Slovenia. The same holds for the EU-15, however, for which the difference in the two cohorts is actually bigger. Indeed, it is only when we look at the enrolment in tertiary education (column 5) that Slovenia rises above the EU-15 average. Further, for enrolment we also have data for the other new member states and Slovenia does even better in terms of enrolment compared to this group. Even in terms of enrolment in tertiary education Slovenia is still behind the US though, which has an impressive enrolment rate of 73% in tertiary education.

The last column in Table 2 gives some numbers on adult education and training, it gives the share of employees that followed any kind of education or training in the 4 weeks preceding the survey ('lifelong learning'). As we see, Slovenia seems to be slightly above the EU-15 average and substantially above the average for the new member states.

Let us conclude with some qualifications. First, how about differences in quality? For the quality of primary and secondary education we can use test scores of internationally comparable tests. Barro and Lee (2001, Table 6) give an overview of average test scores over the period 1994-1998, including average scores for Slovenian pupils. The test is done in 7th grade in the US and at a comparable stage in schools in other countries. Of 39 countries, Slovenia ranks 16th in the mathematics test (in between Thailand and Australia), and 6th in 'science' (in between Austria and Bulgaria). What do we infer from this? My reading is that Slovenia is not necessarily 'behind' regarding the quality of primary and secondary education.

[16] Note, for example, that whereas in 1999 public expenditure on education in the US was close to the EU-15 average, 'average years of schooling' (in 2002) was much higher in the US. This is likely to indicate higher investment in education in the US in the past (and/or more private funding of education).

[17] The data for the average years of schooling are taken from Commission of the Economic Communities (2003), which does not report values for the new member states. The famous Barro and Lee dataset, see *e.g.* Barro and Lee (1993, 2001), has data for all countries in Table 2, but there appear to be some problems with these data, see Section 5 below.

[18] One of the reasons for this was perhaps excessive wage compression during the socialist times.

For example, in both cases Slovenia leaves the US behind (which ranks 22nd and 11th in mathematics and 'science', respectively). However, there is always room for improvement, see *e.g.* the recommendations in OECD (1998).

Tertiary education may be a different story however. For example, Vodopivec (2002) indicates that in Economics most faculty members by far obtained their Ph.D. in Slovenia and have a poor record regarding publications in leading academic journals.[19] One may further wonder whether the dramatic increase in enrolment does not reduce the education 'output' per student of the staff and whether the average student has the same studying potential as before.

Finally, regarding adult education and training our measures of education only capture the fruits of adult education and training insofar as they lead an individual to obtain a higher education degree. Yet this may not be a serious limitation. Recent research casts doubt on the returns from other training and education efforts. For example, Leuven and Oosterbeek (2004) find that the effect of a Dutch adult education and training programme on wages was not significantly different from zero. Although this is only one type of programme in one country, it is important to note that training and education of a short duration can only have a limited impact on productivity, that the returns to education are likely to decline with the knowledge already accumulated, that it is typically assumed that it becomes harder to learn later in life, and that the period in which the training or education yields a return is shorter for older workers (albeit some training and education may also be beneficial in retirement and people will work longer in the future).

[19] Though recently this appears to be changing for the better.

We expect some further physical capital deepening

4. Physical capital

How about physical capital – is there still some room left for improvement there? In Jongen (2004) we calculate that the capital-output ratio in Slovenia in 2002 is somewhere in the order of 2.14, coming from 1.70 in 1995.[20] Table 3 gives some calculations on the capital-output ratio in the EU-15 and the US from Hall and Jones (1999). The capital-output ratio seems to have largely recovered from the contraction of the late 1980s/early 1990s, and is not too far from the EU-15 average.[21]

A good reason for why the capital-output ratio may still have been below the EU-15 average in 2002 was the relatively high interest rate. In 2002, the real interest rate on long-term capital loans was still 7.4% (on average)[22], compared to 3.4%

Table 3: **Capital-output ratio[1]**

Slovenia	2.14
Austria	2.61
Belgium	2.36
Denmark	2.64
Finland	3.13
France	2.68
Germany	2.32
Greece	2.36
Ireland	2.49
Italy	2.54
Luxembourg	-
Netherlands	2.53
Portugal	2.08
Spain	2.33
Sweden	2.38
United Kingdom	1.79
EU-15[2]	2.36
United States	2.25

Notes:
[1] Source: Hall and Jones (1999) for all countries, except Slovenia for which we use data from Jongen (2004). For Slovenia we use the capital-output ratio of 2002, the capital-output ratios for the other countries are for 1988 (but we expect no upward or downward trend in the period 1988-2002).
[2] Weighted average, using the population in 2002 of Groningen Growth and Development Centre (2004) as weights.

[20] The capital stock calculated for 2002 in Jongen (2004) is close to that of Doyle *et al.* (2001), who come to a capital-output ratio of 2.2 in 2000 for Slovenia (2.0 in 2000 in Jongen, 2004). For the construction method and assumptions underlying the capital series see Jongen (2004).

[21] The data for the EU-15 and the US are taken from Hall and Jones (1999). The capital-output ratio calculated by Hall and Jones is for 1988 (due to the data they use from an older version of the Penn World Tables). One of Kaldor's infamous stylised facts (Kaldor, 1963, also see Barro and Sala-i-Martin, 1998) was that the capital-output ratio seemed to be constant over longer periods. Hence, for simplicity we assume that the average capital-output ratio in the EU-15 was the same in 2002 as it was in 1988. Data from OECD (2004) suggest that the capital-output ratio may have grown somewhat over this period. Over the period 1992-2001 they have numbers on the growth in potential GDP and the capital stock in the EU-15 countries. Using the population in 2002 of Groningen Growth and Development Centre (2004) as weights I come to an annual capital deepening of 0.84% per year over the period 1992-2001. Assuming the same capital deepening in the years 1989-1991 and 2002 I come to an average capital-output ratio of 2.66 in 2002 in the EU-15. These tentative calculations suggest there is perhaps still some more room left for further capital deepening in Slovenia than Table 3 suggests.

[22] Source: Bank of Slovenia (30-04-2004) at www.bsi.si.

in the euro-zone.[23] By December 2003 the real interest rate on long-term capital loans had already fallen to 5.2% in Slovenia. With Slovenia entering in the euro-zone in coming years we may expect the real interest rate on long-term capital loans to converge to the euro-zone. This will cause a further rise in the capital-output ratio.

Perhaps another reason we can expect further capital deepening is the relatively low stock of inward foreign direct investment (relative to GDP) in Slovenia (see Section 6). The inward FDI stock was only 17% in Slovenia in 2002 compared to 29% on average in the EU-15 and 34% on average in the new member states for those countries for which we have data.

[23] Source: Eurostat (30-09-2004). I subtracted the average annual rate of change in the harmonized price index of the euro-zone from the average nominal interest rate on long-term capital loans.

5. Total factor productivity

From the analysis above we take that Slovenia is quite close to the EU-15 average in terms of participation, education and capital-intensity (but still quite far from the US in terms of participation and education). In this section we formally try to quantify how much of the differences in GDP per capita can be accounted for by differences in these inputs and how much is left for differences in total factor productivity (TFP), using cross-country 'growth' accounting.

5.1. Methodology

Growth accounting is typically used to calculate the contribution of different inputs to output growth (see Barro, 1998, for a nice introduction). Of particular interest is the 'contribution' of the residual relative to the contribution of other inputs, typically assumed to reflect changes in technology broadly defined and typically found to be a quantitatively important contributor to the growth of GDP per capita (see *e.g.* Solow, 2000). Here, we use the growth accounting approach to account for differences in GDP per capita (in purchasing power parity units) across countries in a given year, following Hall and Jones (1999) and Caselli (2003).[24] Of particular interest is the contribution of differences in TFP, again calculated as a residual, to differences in GDP per capita.

We assume that in all countries j aggregate output $Y_j(t)$ in year t is given by a Cobb-Douglas production function

$$Y_j(t) = A_j(t)(hc_j(t)h_j(t)ep_j(t)P_j(t))^{\beta} K_j(t)^{1-\beta},$$

where $A_j(t)$ denotes total factor productivity, $hc_j(t)$ denotes the human capital per employee, $h_j(t)$ denotes the annual number of working hours per employee, $ep_j(t)$ denotes the employment-to-population ratio, Pj (t) denotes the population, $K_j(t)$ denotes the stock of capital, all for country j at time t, and β denotes the elasticity of output with respect to the effective labour input, which is assumed to be the same across countries. The production function is assumed to exhibit constant returns to scale. Define the capital-output ratio for country j at time t by $\varphi_j(t) \equiv K_j(t)/Y_j(t)$. Making the substitution for the capital-output ratio and with rewriting gives the following expression for GDP per capita

$$Y_j(t)/P_j(t) = A_j(t)^{1/\beta} hc_j(t)h_j(t)ep_j(t)\varphi_j(t)^{(1-\beta)/\beta}.$$

Using the data on GDP per capita and the other inputs in production we can calculate TFP as a residual

$$A_j(t) = \left(\frac{Y_j(t)/P_j(t)}{hc_j(t)h_j(t)ep_j(t)\varphi_j(t)^{(1-\beta)/\beta}} \right)^{\beta}.$$

[24] We extend their analyses by including Slovenia, updating the analysis to 2002 (Hall and Jones (1999) consider 1988, Caselli (2003) considers 1995), and taking into account differences in working hours.

Using the population of the EU-25 countries as weights, we may then also calculate TFP for the EU-25 on average and calculate TFP in each country relative to this average.

5.2. Inputs and results

The data used in the calculation of TFP and the resulting relative TFP numbers are given in Table 4. The data for GDP per capita (in PPP) are taken from IMAD (2004, Table 1). The data for the population, employment and hours per employee

Table 4: **Factors behind differences in GDP per capita, 2002**[1]

	GDP per capita (EU-25=100)[2]	Employment-pop. ratio[3]	Annual hours per employee[4]	Average years of schooling[5]	Capital-output ratio[6]	TFP (EU-25=100)[7]
Slovenia	76	41	1938	11.6	2.14	77
Austria	122	46	1519	12.4	2.61	106
Belgium	118	39	1581	11.1	2.36	125
Denmark	124	50	1505	13.0	2.64	99
Finland	112	46	1604	11.4	3.13	96
France	115	41	1486	10.6	2.68	121
Germany	110	44	1444	13.0	2.32	106
Greece	78	37	1930	10.2	2.36	87
Ireland	137	45	1673	10.6	2.49	121
Italy	108	41	1618	9.7	2.54	115
Luxembourg	208	64	1560	-	-	132
Netherlands	122	51	1324	11.9	2.53	112
Portugal	78	50	1715	7.2	2.08	93
Spain	95	40	1806	9.2	2.33	104
Sweden	115	49	1581	11.7	2.38	101
United Kingdom	118	46	1652	12.0	1.79	111
Cyprus	84	49	2114	-	-	68
Czech Republic	68	46	1913	-	3.08	60
Estonia	44	54	2044	-	-	41
Hungary	58	38	1766	-	2.04	74
Latvia	38	54	2141	-	-	36
Lithuania	43	50	2160	-	-	41
Malta	76	38	1958	-	-	80
Poland	45	36	2201	-	2.07	56
Slovak Republic	52	39	1979	-	2.84	56
EU-15	110	43	1578	11.1	2.36	110
New member states	52	40	2071	-	-	57
EU-25	100	43	1660	-	-	100
United States	152	47	1873	13.3	2.25	108

Notes:
[1] All series are normalized to the EU-25 average, which itself is normalized to 100.
[2] Source: EU-25 from IMAD (2004, Table 1). The data are provisional for 2002 from Eurostat. The relative position of the USA is calculated using data from Groningen Growth and Development Centre (2004).
[3] Employment-to-population ratio. Source: Groningen Growth and Development Centre (2004). Averages are weighted averages using the 2002 populations as weights.
[4] Annual hours worked per employee. Source: Groningen Growth and Development Centre (2004). Averages are weighted averages using the 2002 populations as weights.
[5] Source: Commission of the European Communities (2003) for all countries except Slovenia, for which we use internal calculations by IMAD.
[6] Source: Hall and Jones (1999) for EU-15 countries. Doyle *et al.* (2001) for the Czech Republic, Hungary, Poland and the Slovak Republic, and Jongen (2004) for Slovenia. The data from Hall and Jones (1999) are for 1988, but we expect no trend in the EU-15. Data from the Czech Republic are for 1999, and for Hungary, Poland and the Slovak Republic for 2000.
[7] Total factor productivity, calculated as a residual using cross-country 'growth' accounting, see the main text.

Differences in labour participation, human capital and physical capital between Slovenia and the EU-25 average do not explain the gap in GDP per capita

are from Groningen Growth and Development Centre (2004). The data for human capital are from Commission of the European Communities (2003) for all countries except Slovenia, for which we use data from IMAD. The data for the capital-output ratio are from Hall and Jones (1999) for the EU-15 and the US, from Doyle *et al.* (2001) for those accession countries for which we have data (the Czech Republic, Hungary, Poland and the Slovak Republic), except for Slovenia for which we use data from Jongen (2004).

Let us first consider the differences in GDP per capita. We express GDP per capita relative to the EU-25 (mainly because one of the suggested main goals of the Slovenian government's new strategy is to catch up with the EU-25 in terms of GDP per capita by 2013). In 2002 Slovenia was at about 76% of the average GDP per capita in the EU-25. Within the group of new member states Slovenia ranks second after Cyprus. Compared to the EU-15, Slovenia is already very close to Portugal and Greece but at just over one-third of Luxembourg (as we will see below, this is only partly due to differences in TFP). Finally, in 2002 Slovenians had on average 50% of the GDP per capita of citizens of the US.

Which factors can explain these differences in GDP per capita? The first is the employment-to-population ratio. Note that this is not directly comparable to the employment rates we considered before in Table 1, for those figures were restricted to the working age population. Compared to Table 1, Slovenia is still just below the EU-15, but now not too far above the average of the new member states.

The next column shows the average number of (annual) working hours per employee. Again, Slovenia is in between the EU-15 and the new member states. However, regarding the average number of working hours Slovenia is substantially above the EU-15 average, 23% to be precise, and somewhat below the average of the new member states, namely -6%. Compared to the EU-25, the gap is 14%.[25] Hence, if Slovenians were working the same number of hours that individuals in the EU-25 work on average, GDP per capita would be much lower relative to the EU-25 presuming that this is not offset by any change in the other inputs to production.

The last two columns reveal differences in the human capital per worker and the capital-output ratio, which we already considered above. Unfortunately, we do not have data on the average years of schooling for the other new member states. In our calculations we set the human capital index equal to the EU-15 average for these countries, which may not be too far from the truth though as many former socialist countries had high enrolment rates in education.[26]

Regarding the capital-output ratio, we already noted that Slovenia was somewhat below the EU-15 by 2002. The other transition countries for which we have data show a mixed picture with 2 being above and 2 being below the EU-15 average. For those countries for which we do not have data we therefore simply assume that the capital-output ratio is the same as for the EU-15.

Finally, we assume that β is 0.7, in line with the findings of studies on the labour income share (see *e.g.* Gollin, 2002), which equals the elasticity of output with respect to (effective) labour when the production function is Cobb-Douglas.

[25] The gap is 278 hours, with 40 hours per week this means that Slovenians work on average about 7 weeks per year more than the EU-25 average! A large part of this is probably due to differences in part-time work, which is underdeveloped in Slovenia, see Section 1.

[26] Barro and Lee (2001) do have some data for the accession countries on the average years of schooling. However, at least for Slovenia the data seem rather questionable, see below.

The resulting values for total factor productivity, *i.e.* GDP per capita after controlling for differences in the other inputs, are shown in the last column. Given that Slovenia is very close to the EU-25 average regarding most of the inputs, though the number of hours worked and human capital are above the EU-25 average whereas the capital-output ratio is below the EU-25 average, it should come as no surprise that total factor productivity relative to the EU-25 is very close to GDP per capita relative to the EU-25. For the new member states on average relative TFP is somewhat higher than relative GDP per capita, indicating that their inputs are 'on average' (using the production function to 'weight' the various factors) somewhat lower.

Table 5: **Change in TFP relative to EU-25 average, percentage changes [1]**

	Data for human capital		
	Commission of the European Communities (2003)		Barro and Lee (2001)
	1990-2002	1992-2002	1990-2002
Slovenia	1	4	1
Austria	0	3	2
Belgium	-1	-1	1
Denmark	3	7	3
Finland	8	11	6
France	-2	1	-7
Germany	8	7	7
Greece	-7	-5	-2
Ireland	22	20	25
Italy	-9	-7	-8
Luxembourg	-3	-4	-3
Netherlands	-10	-6	-9
Portugal	3	-2	4
Spain	-17	-16	-14
Sweden	-1	2	-5
United Kingdom	-1	-1	3
Cyprus	5	7	5
Czech Republic	-10	-2	-7
Estonia	-6	17	-6
Hungary	10	11	13
Latvia	-27	11	-27
Lithuania	-23	-1	-23
Malta	10	6	9
Poland	27	24	29
Slovak Republic	11	18	15
EU-15	-2	-1	-2
New member states	9	14	11
EU-25	0	0	0
United States	0	2	-3

Note:
[1] TFP relative to the EU-25 is calculated in all years using cross-country 'growth' accounting. The data used in the calculations are from Groningen Growth and Development Centre (2004) for GDP per capita in PPP, the employment to population ratio and hours worked per employee. For 1990 and 1992 we use data on average years of schooling for 1990 from Commission of the European Communities (2003) and Barro and Lee (2001), and for 2002 we use data for 2002 from Commission of the European Communities (2003) and the projection for 2000 from Barro and Lee (2001). The capital-output ratio in the EU-15 is assumed to remain constant at the level of 1988. The capital-output ratio for Slovenia is taken from Jongen (2004). The capital-outpu ratio for the Czech Republic, Hungary, Poland and the Slovak Republic are taken from Doyle *et al.* (2001), where we use data from 1999 for the Czech Republic for 2002 and data from 2000 for Hungary, Poland and the Slovak Republic, the end data of these data series in Doyle *et al.* (2001). For the transition countries for which we do not have data we set the human capital index and the capital-output ratio equal to the EU-15 average.

Looking at the results for some other countries, we note that the US is actually not doing better than the average EU-15 country in terms of TFP (see Blanchard, 2003, for a similar observation). Indeed, its higher GDP per capita is due to the relatively high participation rate of its population, both in persons and in hours, and the relatively high education level. A similar story holds for Luxembourg, whose TFP is only 32% higher than the average of the EU-25 (though it still has the highest TFP in the set of countries considered), compared to more than 100% in terms of GDP per capita.[27] Furthermore, a large part of the relatively favourable GDP per capita in Ireland seems to be due to TFP, whereas Finland does relatively poorly in terms of TFP (both countries are sometimes considered as examples for other countries in terms of certain economic policies).

Of perhaps even bigger interest is the development of TFP over time. Have the new member states been able to catch up with the EU-15 in terms of TFP? Table 5 gives some insight into this question. We present results using two different datasets for average years of schooling. The first two columns give the results using our preferred data series for average years of schooling from Commission of the European Communities (2003). As a robustness check, the third column gives the results using the latest version of the famous Barro and Lee (1993, 2001) dataset. We did not use this dataset in Table 4 because the average years of schooling for Slovenia is unrealistically low in the Barro and Lee dataset.[28] Indeed, in 1990 the average years of schooling is below such illustrious countries as Romania and Cuba, and even below the average for all of Yugoslavia. This goes against common wisdom regarding the level of education in Slovenia. Another problem with the Barro and Lee dataset is that the share of individuals with no education increases from 0.7% in 1990 to 4.9% in 2000, again running against common wisdom regarding the development of education in Slovenia. Still, for the development of TFP over time we are only interested in relative changes in average years of schooling, which seems not unreasonable, increasing by 6% over the period 1990-2000, compared to 4% according to data from IMAD (see Jongen, 2004).

Over the past decade Slovenia has been able to close only a small part of its total factor productivity gap with the EU-25 average, contrary to the new member states on average

Turning to the results, let us first consider the results with our preferred data on average years of schooling. Over the period 1990-2002 TFP relative to the EU-25 average increased by 1%. Although this suggests Slovenia has been catching up with the EU-25 in TFP terms, the catch up is almost negligible compared to the average for the new member states over this period (which is mainly driven by Poland's large gain in relative TFP over this period), 9%. These results are relatively sensitive to the starting point we choose for the comparison, however. The second column suggests that Slovenia was able to gain more ground relative to the EU-25 over the period 1992-2002. However, the gap that was closed by Slovenia was still much smaller than the average for the new member states, whose relative TFP grew at 14% over this period. Part of the difference in TFP growth using different starting points can perhaps be explained by the fact that we measure TFP as a residual. Hence, if *e.g.* the change in employment and the capital stock do not fully capture the decline in utilisation rates of these factors, TFP will be understated in the bottom of the 'transformational recession'. The fact that this

[27] Note that we do not have data on (the presumably above average) human capital variable.

[28] De la Fuente and Domenech (2002) consider some further potential shortcomings of the Barro and Lee dataset. De la Fuente and Domenech (2002) also construct an alternative series for a small group of OECD countries (and do not consider Slovenia) for 1995. The series of the Commission of the European Communities (2003) used in Tables 4 and 5 are an extrapolation of the De la Fuente and Domenech (2002) dataset. Other datasets are given in Cohen and Soto (2001) and Nehru *et al.* (1995), none of these includes Slovenia however.

'transformational recession' was not synchronised, shifting the starting point one or two years can already make quite a difference, as shown in Table 5.[29]

As a further robustness check we consider the gain in relative TFP for the various countries when we use the Barro and Lee dataset on average years of schooling.[30] The relative gain in TFP for Slovenia is (almost) the same. The average relative gain for the new member states is a bit higher. All member states for which we have data (Czech Republic, Hungary, Poland and the Slovak Republic) lose ground to the EU-15 average in terms of average years of schooling in the Barro and Lee dataset over the relevant period. Hence, TFP growth (the residual) ends up a bit higher than without controlling for relative changes in human capital over the period.

One final remark, according to data from Groningen Growth and Development Centre (2004) GDP per capita (in PPP) in Slovenia relative to the EU-25 grew by about 18% over the period 1992-2002. Over the same period we calculate growth in relative TFP of 'only' 4%. Hence, most of the convergence with the EU-25 over this period was driven by the growth in labour and capital input.[31] With the participation of labour, education and capital-output ratio's close to the EU-average in 2002, these factors may become less important for future convergence with the EU-25, (though in some sub-areas there is still ample room for improvement regarding these inputs, see above).

5.3. Limitations

The results above should be interpreted with the appropriate care however. First, there are problems with data availability. For example, for most new member states we do not have data on the human and physical capital stock. Consider again the first column with results in Table 5. We observe a large drop of 27% and 23% in relative TFP over the period 1990-2002 for Latvia and Lithuania. However, this may in part be driven by the drop in physical capital for which we do not have data, which therefore ends up in TFP. Fortunately, we do have data on the capital stock for the by far largest new member state, Poland.

Second, there are problems with data comparability. Specifically, differences in TFP may in part simply reflect differences in quality in *e.g.* schooling or capital. This may be particularly problematic for transition countries. For example, it is hard to determine how much physical and human capital became obsolete during the transition. However, we should not be too pessimistic regarding the distortion of quality differences. Caselli (2003) finds that allowing for differences in the quality of inputs in production does not qualitatively affect his cross-country comparison of TFP. Furthermore, he also finds that the use of different datasets for the inputs does not qualitatively affect the results. Unfortunately, his analysis does not single out Slovenia.

[29] The big difference in relative TFP growth in columns 1 and 2 for a country like Latvia is not a mistake. According to Groningen Growth and Development Center (2004) GDP per capita fell by almost 50% in Latvia in a few years time!

[30] Source: www.columbia.edu/~xs23/data/barrlee.htm (30-04-2004).

[31] For a similar finding regarding the 'Asian tigers' see Young (1995). This suggests that the convergence with the Western world is a costly process of capital accumulation and higher working hours, rather than a costless adoption of more efficient technologies and institutions.

Third, we assume that the production function is Cobb-Douglas in all countries, and that the relative weight of effective labour in production is the same in all countries. Caselli (2003) shows that allowing for more or less substitution, but still assuming the same substitutability in all countries between effective labour and capital, using a CES production function does make quite a difference to the results. Caselli and Coleman II (2004) further find that allowing for imperfect substitutability between workers of different skill types and differences in TFP across skill types also makes a big difference. Yet one should note that these studies are more concerned with differences between rich and poor countries around the globe. The differences in the production structure are likely to be bigger between rich and really poor countries than between Slovenia and the EU or US. However, the analysis of Caselli (2003) and Caselli and Coleman II (2004) does show that one has to be careful in relying too much on the Cobb-Douglas form of the production function.

Another type of problem with this type of analysis is that, although it ‘accounts’ for differences in GDP per capita, it ‘does not attempt to explain how the changes in inputs and the improvements in total factor productivity relate to elements – such as aspects of preferences, technology, and government policies – that can reasonably be viewed as fundamentals’ (Barro and Sala-i-Martin, 1998, p. 352).

6. Explaining the TFP gap

The growth accounting exercise above suggests that a sizeable gap between TFP in Slovenia and the EU-25 remains in 2002. Which factors can explain this gap?[32] Below we consider differences in the following candidates (for which we have internationally comparable data): i) resources devoted to research and development (R&D), 'openness' (trade and foreign direct investment), both R&D and 'openness' being an indication of the exposure of the Slovenian to new technologies; ii) 'absorption capacity' for new technologies (job and worker flows); and iii) other factors like the size of the government and the 'rule of law'.

6.1. R&D

Slovenia lags behind the EU-15 in terms of the quantity and perhaps the quality of R&D

TFP is calculated as a residual, but is typically assumed to reflect in part the state of technology in a country. One factor for TFP growth that has received much attention in the literature is R&D. Where a higher share of GDP is spent on R&D this results in an increase in the level of GDP in the medium- and perhaps even long-run.[33] Table 6 gives some indicators for the quantity and quality of R&D in Slovenia relative to EU countries and the US, in 2001.

In the first column we find expenditures on R&D as a percentage of GDP. Slovenia scores much better on this indicator than the average new member state, but is still somewhat behind the EU-15 and EU-25 average. The gap vis-à-vis the US is much bigger, which holds for most EU countries (Finland and Sweden being notable exceptions).

The second column gives the number of researchers as a percentage of the population. Also according to this measure Slovenia does relatively well relative to the new member states and lags behind the EU-15. However, in terms of the percentage of researchers Slovenia is closer to the average of the new member states than to the EU-15 (although data on more countries in the EU-15 is missing for this indicator than for R&D as a percentage of GDP).

The other columns give indicators of the quality of R&D in Slovenia. First, the private sector takes a lower share of total R&D in Slovenia than in the EU-15, and in particular than in the US, but again it is above the average of the new member states. Public R&D expenditures are typically assumed to be less productive than private sector R&D (Cameron, 1998). When we consider the number of patent applications per 1 million inhabitants (columns 4 and 5), we find that the gap with the EU-15 and the US widens. This may indicate that Slovenian R&D is, on average, less productive than EU-15 and US R&D, but it may also indicate that Slovenian R&D is more about imitation than invention.[34] Overall, we

[32] One of the main findings of Hall and Jones (1999) is that huge differences in GDP per capita around the globe remain after controlling for differences in labour input, human capital and physical capital. They then continue to explain these residual differences with differences in 'social infrastructure' and use indicators such as distance to the equator and the share of the population speaking English as instruments for social infrastructure (also see Acemoglu *et al.*, 2004). Here we take a more mundane approach, quantifying differences in other inputs such as R&D *etc*.

[33] In semi-endogenous growth models, a higher R&D share will increase the level but not the growth rate of GDP in the long run, in endogenous growth models a higher R&D share also increases the growth rate of GDP in the long run. Whether or not growth is endogenous or semi-endogenous is a hotly debated topic, see *e.g.* Dalgaard and Kreiner (2003), Ha and Howitt (2003), Jones (2003), Li (2003) and Solow (2000).

[34] For more on the quality of Slovenian R&D, see Fritsch (2002) and Ministry of the Economy (2003, Chapter 8).

Table 6: **Indicators of quantity and quality of R&D, 2001**[1]

	R&D as % of GDP	Number of researchers per 1000 workforce	Share of business R&D, in %	Patents at EPO (per mln. inhab.)[2]	Patents at US PO (per mln. inhab.)[3]
Slovenia	1.6	4.6	55	41	13
Austria	1.9	-	41	174	83
Belgium	2.2	-	-	152	93
Denmark	2.4	6.9	62	211	106
Finland	3.4	13.8	71	338	156
France	2.2	-	-	145	77
Germany	2.5	6.6	66	310	147
Greece	-	-	-	8	3
Ireland	1.2	5.0	67	86	49
Italy	1.1	-	50	75	33
Luxembourg	-	-	-	-	-
Netherlands	-	-	-	243	99
Portugal	0.8	3.4	32	6	2
Spain	1.0	4.5	47	24	9
Sweden	4.3	10.1	72	367	214
United Kingdom	1.9	11.6	90	134	77
Cyprus	0.3	1.1	15	15	3
Czech Republic	1.3	2.9	52	11	3
Estonia	0.8	3.8	33	11	2
Hungary	1.0	3.6	35	19	7
Latvia	0.4	3.2	18	8	1
Lithuania	0.7	4.6	36	2	1
Malta	-	-	-	-	-
Poland	0.7	3.3	31	3	1
Slovak Republic	0.6	3.7	60	6	1
EU-15	1.9	7.7	63	161	80
New member states	0.8	3.4	37	8	3
EU-25	1.7	6.4	58	136	68
United States	2.8	-	75	170	323

Notes:
[1] Source: Eurostat (30-04-2004), except for Italy and the US for which we use data from OECD (2003b).
[2] Patents at European Patent Office, per million inhabitants.
[3] Patents at US Patent Office, per million inhabitants.

conclude that part of the gap in TFP with the EU-25 can be explained by the lower quantity and perhaps quality of R&D in Slovenia.

6.2. Trade and foreign direct investment

Domestic R&D is probably an important determinant of TFP. However, exposure to foreign technology and institutions may also lead to an increase in TFP as individuals in different countries learn from each other when they interact. Two main channels for interaction are imports and exports, and inward and outward foreign direct investment (FDI).[35]

[35] Furthermore, over and above technology transfer, trade and FDI may further enhance GDP growth via other channels, like increasing specialisation and a lower cost of capital.

6.2.1. Trade

The consensus view appears to be that more open economies grow faster (Ben-David, 2000; Sala-i-Martin, 2001), although the issue is not settled (Rodríguez and Rodrik, 1999). For Slovenia we can take a somewhat less controversial position, which is that economies that trade intensively with each other converge in terms of per capita income, see *e.g.* Ben-David (2000) for an interesting look at some European data. As most trading is with the EU (see below), we may expect a faster convergence with the EU regarding TFP when trade increases following the entrance of Slovenia into the EU.

Table 7 gives an overview of imports and exports relative to GDP for Slovenia and the other countries for 2002. Slovenia is above-average regarding imports and exports when we consider the EU-15 or the new member states.[36] Slovenia is

Table 7: **Trade and FDI, 2002**[1]

	Imports as % of GDP	Exports as % of GDP	Share of imports to EU-15 in %	Share of exports to EU-15 in %	Inward FDI stock as % of GDP	Outward FDI stock as % of GDP
Slovenia	49	47	68	59	17	6
Austria	38	38	-	-	21	20
Belgium	81	88	-	-	82	73
Denmark	29	33	-	-	42	43
Finland	26	34	-	-	33	33
France	23	23	-	-	9	5
Germany	25	31	-	-	27	53
Greece	23	8	-	-	28	46
Ireland	43	72	-	-	129	30
Italy	21	21	-	-	11	16
Luxembourg	-	-	-	-	-	-
Netherlands	52	58	-	-	75	85
Portugal	33	22	-	-	36	26
Spain	25	19	-	-	23	29
Sweden	28	34	-	-	46	61
United Kingdom	22	18	-	-	41	66
Cyprus	36	4	56	53	55	2
Czech Republic	55	52	60	68	66	11
Estonia	74	53	58	68	-	-
Hungary	58	53	56	75	38	7
Latvia	48	27	53	60	32	1
Lithuania	53	37	45	50	31	1
Malta	63	49	67	46	-	-
Poland	29	21	62	69	24	1
Slovak Republic	68	59	50	61	43	2
EU-15	27	27	-	-	29	39
New member states	43	35	59	67	34	3
EU-25	29	29	-	-	30	33
United States	11	6	-	-	13	14

Note:
[1] Import and export data are from Eurostat (30-04-2004), FDI data are from Unctad (2003). The averages for EU-15, the new member states and the EU-25 are weighted averages using the population data of Groningen Growth and Development Center (2004) in 2002 as weights.

[36] The share of exports in GDP is surprisingly low in Cyprus in 2002 according to Eurostat.

Slovenia is in a good position to benefit from technology transfer through international trade

also far above the US in this respect. This is not surprising given that Slovenia is a relatively small country and hence is more likely to depend on trade. This is not to downplay the relative importance of trade for technology transfer however. Indeed, as a small country, foreign factors are typically relatively important for domestic output and TFP.

In brackets we give imports from and exports to the EU-15 as a share of total imports and exports per country, in which direction we hope that TFP will converge. We find that Slovenia is above-average regarding imports, and below-average regarding exports relative to the other new member states on average. This may be a favourable mix, as Keller (2004) suggests that imports matter more for domestic technology than exports (importing technology is more important than 'learning-from-exporting').

Returning to our main theme, is there still room for improvement? Probably there is. Indeed, accession to the EU-15 may help in bringing down explicit (*e.g.* tariffs, quotas and exchange rate risks) and other (*e.g.* cultural) barriers to trade. We conclude that Slovenia's relative openness means it is in a relatively favourable position to adopt technology from other countries via trade.

6.2.2. Foreign direct investment

In terms of inward FDI, Slovenia lags behind the other new member states

Whether or not FDI stimulates growth or convergence appears to be more controversial than trade. The consensus view once appeared to be that micro-level studies found no impact of FDI on TFP, whereas macro-level studies typically found that more FDI raises TFP (if some complementary factors were present). This seems to have changed. Reviewing the latest findings, Keller (2004) concludes that FDI raises TFP when using micro-level data. However, an extensive robustness check of Carkovic and Levine (2002) on macro-level data suggests that FDI does not affect TFP, also not conditional on the level of human capital and other factors believed to be complementary to FDI effects on TFP.[37] However, it is hard to imagine that more trade and FDI lowers TFP. Indeed, personal contacts with foreigners seem to matter for technology transfer, see *e.g.* Keller (2004), and trade and FDI may be expected to increase the number of contacts with foreigners.

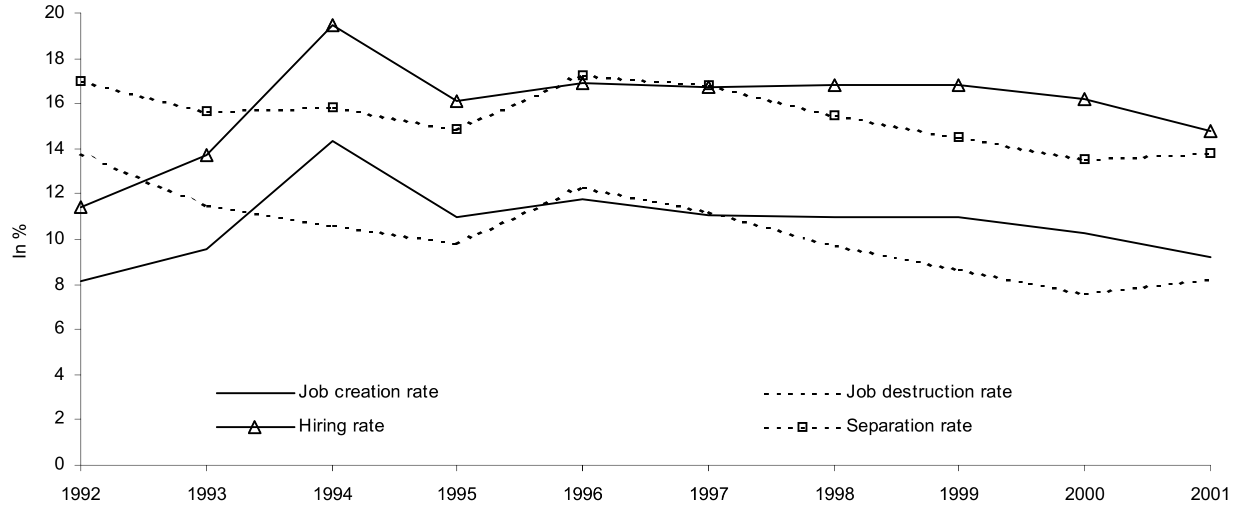
Table 7 shows that if more FDI is beneficial for TFP, Slovenia has relatively much to gain since it is a clear outlier. Column 3 displays the capital stock of inward FDI while column 4 shows the capital stock of outward FDI, both as a percentage of Slovenian GDP in 2002. Slovenia is far behind the average of the new member states regarding inward FDI, but also relative to the EU-15.

6.3. Absorption capacity

Whereas R&D, trade and FDI may give us an idea of the 'exposure' of Slovenian firms and workers to new technologies, job and worker flows may give us an indication of how quickly new technologies are absorbed by the Slovenian economy. Job and worker flows give an indication of the pace of 'creative destruction' (Schumpeter, 1975) in the economy, the idea being that technology is largely

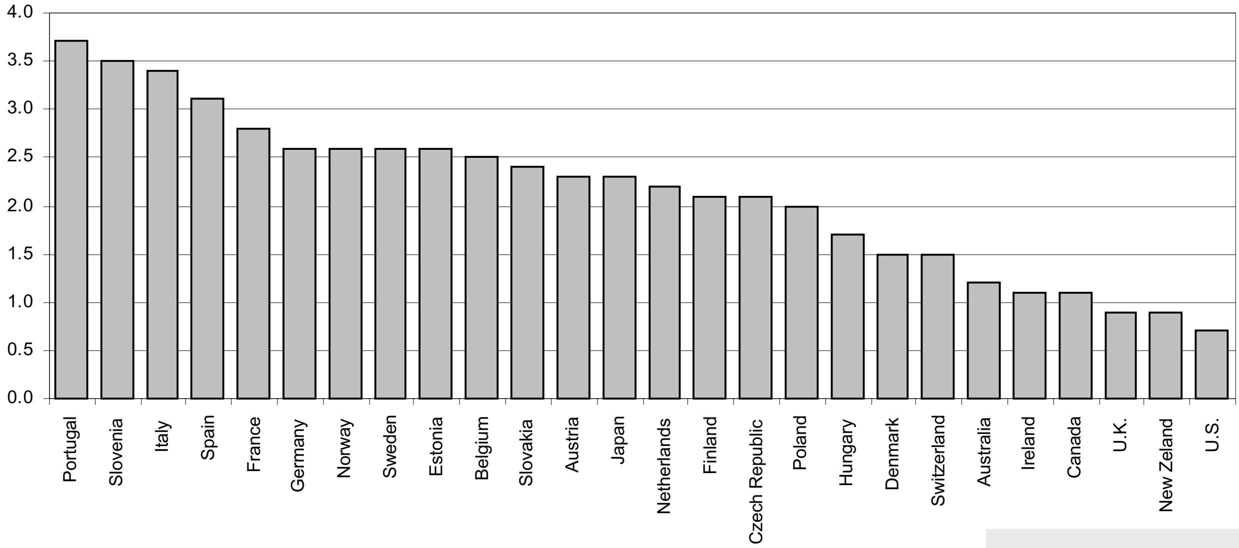
[37] The studies of Carkovic and Levine (2002) for FDI and Rodríguez and Rodrik (1999) for trade highlight a typical problem in cross-country studies on the effects of FDI and trade. These studies often omit variables that can explain both above-average TFP, trade and FDI

Figure 1: **Job and worker flows in Slovenia**



Source: Vodopivec (2004). **Note**: The job creation rate is the share of jobs created at expending plants over the stock of employment, the job destruction rate is the share of jobs destroyed at contracting plants. The hiring rate is the inflow of employees over the stock of employment, the seperation rate is the outflow of employees over the stock of employment.

Figure 2: **Indicators of employment protection legislation**



Source: Riboud *et al.* (2002). **Note**: low=1, high=6.

embodied in production units which must be reallocated to absorb the new technologies.[38]

Figure 1 shows the flow of jobs and workers in Slovenia for the 1992-2001 period. The lower two lines are the annual job creation and destruction rates (in %). The job creation rate is the share of jobs created at expanding plants over the stock of employment. The job destruction rate is the share of jobs destroyed at contracting plants (see Davis *et al.*, 1996, for the methodology of measuring job and worker flows). There appears to be a downward trend in job destruction, which may indicate

[38] The link between embodied technology and creative destruction rests on a relatively subtle assumption, namely the incumbent firm is typically assumed to have less of an incentive to develop or adopt the new technology than others, see *e.g.* Aghion and Howitt (1998). But indeed, one does observe large job and worker flows in narrowly defined industries, which do seem to be driven at least in part by technology adoption, see *e.g.* Davis *et al.* (1996).

There are no clear indications that institutions have held back job flows in Slovenia, though worker flows seem to be relatively low

the restructuring of the economy following the separation from the rest of Yugoslavia in the early 1990s. We see that job creation responded with a lag, and after 1994 also appears to display a mild downward trend, again suggesting that restructuring was more intense in the early 1990s than in recent years.

Figure 1 also gives the (remarkably similar) flow rate (in %) of workers in and out of jobs (which can be either from a job to no job or *vice versa*, or from one job to another). The worker flows are always larger than job flows as a job cannot change without a worker, but a worker can change without a job (by the definition used). The question is: are these flows below average, above average or just average?

Before we consider the international data, let us first consider some reasons why we may expect these flows to be lower or higher in Slovenia than in other countries. Figure 2 gives indicators of the strictness of employment protection legislation for OECD countries and the new member states. As we can see, Slovenia ranks second after Portugal! (recently employment protection has become less strict in Slovenia, see Riboud *et al.*, 2002) This accords with the common wisdom that, at least until recently, even after the 'desocialization' employment protection was still relatively strict for a long time in Slovenia (see Riboud *et al.*, 2002 for the components of the EPL index for each transition country). Stricter employment protection is typically assumed to reduce job and worker flows.

Furthermore, at least for some time reallocation may further have been hampered by taxing productive sites to subsidise unproductive sites (to 'save' jobs), 'soft budget constraints' for unproductive sites and high costs for starting up new businesses (see below). Table 8 gives an indication of the costs of starting and closing a business in Slovenia relative to the other countries. The Worldbank and International Finance Corporation (2004) asked local experts to determine how many procedures one needs to go through, how much time it takes and what is the initial cost for starting and closing a business in all the countries, assuming the start-up or closure of a hypothetical representative business which was the same in all countries. We see entrepreneurs in Slovenia have to deal with more procedures and have to devote more time to start up a business in Slovenia relative to the EU-15 and the other new member states on average. On the positive side, the required monetary start-up costs and in particular the start-up capital are relatively low compared to the average new member states. Regarding closing a business (which is important for entrepreneurs wanting to start an alternative business), Slovenia does not appear to be out of line, although the cost is substantially higher than in the other EU countries on average.

Most of the above indicators suggest that institutions related to resource reallocation may have held back the reallocation of workers and other inputs from less to more productive sites. However, on the other hand we may expect job flows to be higher for Slovenia than, for example, the EU-15 countries as there was a bigger need for restructuring in Slovenia than in the EU-15.

Let us now consider the international data. Table 9 presents the results from some studies on job creation and destruction rates. Comparing these data across countries is tricky as the studies typically do not compare the same flows. The preferred data are given first, where the criteria are that the data had to cover the whole economy (not only, say, manufacturing), the data period was as long as possible, and also included small firms. We do not have data for all countries that satisfy these criteria and we will highlight some perhaps crucial differences below in the comparison.

Table 8: **Costs of starting and closing a business, 2003**[1]

	Starting a business				Closing a business	
	Number of procedures	**Duration (in days)**	**Cost (% of GNI per capita)**[2]	**Min. capital (% of GNI per capita)**[3]	**Actual time (in years)**	**Actual cost (% of estate)**
Slovenia	10	61	12	20	2	18
Austria	9	29	6	66	1	18
Belgium	4	34	12	14	1	4
Denmark	4	4	0	50	4	8
Finland	3	14	1	30	2	18
France	7	8	1	29	3	1
Germany	9	45	6	49	na	na
Greece	15	38	36	135	4	18
Ireland	4	24	10	0	4	38
Italy	9	13	23	12	1	18
Luxembourg	-	-	-	-	-	-
Netherlands	7	11	13	67	2	4
Portugal	-	-	-	-	-	-
Spain	6	108	17	18	2	18
Sweden	3	16	1	39	5	4
United Kingdom	6	18	1	0	3	4
Cyprus	-	-	-	-	-	-
Czech Republic	10	88	11	47	9	38
Estonia	6	72	8	53	2	8
Hungary	6	52	23	96	11	8
Latvia	7	17	17	45	4	18
Lithuania	8	26	4	68	4	38
Malta	-	-	-	-	-	-
Poland	10	31	21	247	3	8
Slovak Republic	9	52	6	50	4	18
EU-15	7	32	9	30	1.9	8
New member states	9	44	17	160	3.5	11
EU-25	8	34	11	52	2.2	8
United States	5	5	1	0	4	8

Notes:
[1] Source: Worldbank and International Finance Corporation (2004).
[2] Cost to start up a business, as a percentage of gross national income per capita.
[3] Startup capital required to start a business, as a percentage of gross national income per capita.

Our preferred data are from Vodopivec (2004) for Slovenia[39], from Gomez-Salvador *et al.* (2004) for the EU-15, from Faggio and Konings (2001) for Estonia and Poland and from Haltiwanger (2004) for the US. In brackets we give data from the study of Faggio and Konings (2001), which is the only study that presents comparable data on Slovenia, some EU countries and two other new member states. This is not our preferred series for Slovenia and the EU countries (for which we have data) however, as the sample is restricted to large firms (>100 employees).

We present data on the following variables: a) the job creation rate, the creation of jobs at expanding plants over the stock of employment; b) the job destruction rate,

[39] Various studies on job (and worker) flows in Slovenia exist, apart from Vodopivec (2004) see *e.g.* Bojnec and Konings (1998), De Loecker and Konings (2003), Faggio and Konings (2001) and Haltiwanger and Vodopivec (2003).

Table 9: **Job creation and destruction rates, in %, average for 1990s** [1]

	Job creation rate	Job destruction rate	Job reallocation rate[2]	Net employment growth rate[3]	Excess job reallocation rate[4]
Slovenia	(4) 11	(5) 10	(10) 21	(-1) 0	(9) 21
Austria	5	3	8	1	7
Belgium	(4) 5	(3) 4	(7) 9	(0) 1	(6) 8
Denmark	6	3	10	3	7
Finland	7	3	10	4	6
France	5	3	8	2	7
Germany	(5) 4	(4) 4	(9) 8	(0) 1	(9) 7
Greece	-	-	-	-	
Ireland	9	3	12	5	6
Italy	8	4	12	4	8
Luxembourg	-	-	-	-	
Netherlands	(7) 7	(3) 4	(9) 11	(4) 2	(5) 9
Portugal	5	4	8	2	7
Spain	9	3	12	5	7
Sweden	8	4	12	5	7
UK	(5) 7	(5) 4	(11) 11	(0) 2	(11) 9
Cyprus	-	-	-	-	
Czech Republic	-	-	-	-	
Estonia	8	8	16	0	16
Hungary	-	-	-	-	
Latvia	-	-	-	-	
Lithuania	-	-	-	-	
Malta	-	-	-	-	
Poland	3	5	9	-2	7
Slovak Republic	-	-	-	-	
EU-15	6	4	10	2	8
New member states	-	-	-	-	-
EU-25	-	-	-	-	-
United States	11	10	21	1	20

Notes:
[1] Source: Gomez-Salvador *et al*. (2004) for the EU-15 (series range from 1992 to 2001 (when available)), Faggio and Konings (2001) for Estonia and Poland (series range from 1994 to 1997), except for Slovenia for which we use data from Vodopivec (2004) for which the series range from 1992-2001. For the US we use data from Haltiwanger (2004) which range from 1979-1983. In brackets are the data from Faggio and Konings (2001) for comparison. The EU-15 average is a weighted average using the population in 1996 from Groningen Growth and Development Centre (2004) as weights.
[2] Job reallocation rate (= job creation rate + job destruction rate).
[3] Net employment growth rate (= job creation rate - job destruction rate).
[4] Excess reallocation rate (= job creation rate - | job destruction rate |).

the destruction of jobs at contracting plants over the stock of employment; c) the job reallocation rate, the sum of job creation and destruction rates; d) the net employment growth rate, the job creation rate minus the job destruction rate; and e) the excess reallocation rate, the gross reallocation rate minus the absolute value of the net employment growth rate, indicating the reallocation of jobs over and above the adjustment required to meet the change in net employment.

The data from Vodopivec (2004) covers the whole economy for a decade. The only data comparable to this is data from the US (the other studies do not consider the smallest firms). The flows are almost of a similar magnitude in Slovenia and the US.

Next, comparing the data from the EU-15 to the US we see that these are substantially lower on average. However, the data are not comparable as Gomez-Salvador *et al.* (2004) restrict the sample to larger firms. Data from Haltiwanger (2004) show that flows in the EU-15 are actually quantitatively not that different from the US.

Turning to the flows reported in Faggio and Konings (2001), see the numbers in brackets, we also have data for Estonia and Poland and some EU-15 countries. Compared to the EU-15 countries we find that the flow rates in Slovenia are not that different. Compared to the two other new member states we find that the flow rates are bigger than in Poland but much smaller than in Estonia. Faggio and Konings (2001) also report data for Bulgaria and Romania (not in the table). The gross reallocation rate for Bulgaria is comparable to Slovenia, whereas the excess reallocation rate is lower than in Slovenia. For Romania, they find that the gross reallocation rate is higher than in Slovenia and the excess reallocation rate is comparable to Slovenia. Overall, Slovenia does not appear to stand out.

Finally, conclude with some remarks regarding worker flows. This may be a different story. Data from Vodopivec (2004) suggest that for the period 1992-2001 the average hiring and separation rates were about 50% higher than the job creation and destruction rates. This is relatively low by international standards. Indeed, Haltiwanger (2004) suggests that across countries worker flows are on average about 100% to 200% higher than job flows. Haltiwanger and Vodopivec (2003) consider the relative low worker flows in Slovenia in depth, where wage compression (differences in wages being smaller than differences in productivity's across workers/jobs) seems to be a limiting factor.[40]

What do we make of this analysis? My reading is that, despite some indicators suggesting that job flows may have been held back in Slovenia over the past decade, these flows are quite similar to most EU-15 countries and the US. Yet, the flow rates are a bit lower than in some other new member states. Insofar as this does not reflect a different stage in the transition (Slovenia being ahead in the transition process), this could still be taken as an indication that job flows have been held back to some extent in Slovenia. Note though that recently some of these institutions have become less restrictive.

Finally, worker flows seem to be relatively low in Slovenia, suggesting that there is at least some further room for improvement regarding the flow of workers. But again, this may change since employment protection legislation has become less strict.

6.4. Other factors

Clearly, many other factors play a part in the gaps in TFP across countries. Here we consider some further indicators for which we have internationally comparable data.[41]

[40] Another limiting factor on worker mobility might be frictions on the housing market like credit constraints.

[41] Further international comparisons related to this study can be found in EBRD (2003), IMD International (2003) and World Economic Forum (2003). We present only data from Worldbank and International Finance Corporation (2004). EBRD (2003) only gives indices on a discrete scale whereas World Economic Forum (2003) relies heavily on survey data which are hard to compare across countries (but perhaps not across time). The data source description in IMD (2003) is rather imprecise.

It takes relatively much time to enforce a contract in Slovenia

We already came across the interesting study of the Worldbank and International Finance Corporation (2004) when we looked at the costs of starting up and closing a business in Table 8. They also considered the time and costs it takes to enforce contracts, how much individuals use credit and an index of the strength of creditors' rights (see Table 10). According to this study, it is very time consuming to enforce a contract in Slovenia, which can take almost 3 years. Together with Poland, Slovenia has the longest time needed to enforce a contract. This may have held back the number of productive transactions in Slovenia. Regarding the use of credit, Slovenians are far below the EU-15 average[42] and somewhat above the average

Table 10: **Contract enforcement costs and credit facilities, 2003**[1]

	Number of procedures	Duration (in days)	Cost (% of GNI per capita)[2]	Procedural complexity index	Public credit registry coverage, in %[3]	Private bureau coverage, in %[4]	Creditor rights index
Slovenia	22	1003	4	65	1	0	3
Austria	20	374	1	54	1	31	3
Belgium	27	112	9	54	7	4	2
Denmark	14	83	4	40	0	6	3
Finland	19	240	16	48	0	10	1
France	21	210	4	79	1	0	0
Germany	26	154	6	61	1	69	3
Greece	15	315	8	64	0	9	1
Ireland	16	217	7	42	0	73	1
Italy	16	645	4	64	6	42	1
Luxembourg	-	-	-	-	-	-	-
Netherlands	21	39	1	46	0	53	3
Portugal	22	420	5	54	50	2	1
Spain	20	147	11	83	31	5	2
Sweden	23	90	8	44	0	49	1
United Kingdom	12	101	1	36	0	65	4
Cyprus	-	-	-	-	-	-	-
Czech Republic	16	270	19	65	1	14	3
Estonia	-	-	-	-	-	-	-
Hungary	17	365	5	57	0	2	2
Latvia	19	189	8	56	0	0	3
Lithuania	17	74	13	58	1	0	2
Malta	-	-	-	-	-	-	-
Poland	18	1000	11	65	0	54	2
Slovak Republic	26	420	13	40	0	0	2
EU-15	20	238	5	61	6	38	2.0
New member states	18	692	11	61	0	31	2.2
EU-25	19	311	6	61	5	37	2.1
United States	17	365	0	46	0	81	1

Notes:
[1] Source: Worldbank and International Finance Corporation (2004). The averages for the EU-15, new member states and EU-25 are weighted averages using the population of Groningen Growth and Development Centre (2004) as weights.
[2] Cost as a percentage of gross national income per capita.
[3] Percentage of borrowers relative to population registered at public registry.
[4] Percentage of borrowers relative to population registered at private registry.

[42] See also Coricelli and Masten (2004).

Table 11: **Government expenditures, and state aid, as a % of GDP, 2002**

	Government expenditures[1]	State aid total[2]	State aid excl. agriculture and fisheries[3]
Slovenia	48	1.36 [4]	0.49
Austria	51	0.63	0.21
Belgium	51	0.53	0.37
Denmark	56	0.92	0.72
Finland	50	1.28	0.17
France	54	0.66	0.42
Germany	49	0.65	0.56
Greece	47	0.52	0.31
Ireland	33	0.85	0.45
Italy	48	0.50	0.38
Luxembourg	44	0.41	0.26
Netherlands	48	0.46	0.19
Portugal	46	0.83	0.55
Spain	40	0.68	0.55
Sweden	58	0.39	0.16
United Kingdom	41	0.25	0.17
Cyprus	42	-	-
Czech Republic	52	-	-
Estonia	-	-	-
Hungary	53	-	-
Latvia	39	-	-
Lithuania	34	-	-
Malta	-	-	-
Poland	-	-	-
Slovak Republic	51	-	-
EU-15	47	0.56	0.39
New member states	-	-	-
EU-25	-	-	-
United States	39	-	-

Notes:
[1] Government expenditures as a percentage of GDP. Source: Eurostat (30-04-2004) for all countries except Slovenia, for which we use Statistical Office of the Republic of Slovenia (2004), and the US, for which we use IMD International (2003).
[2] State aid (excluding aid to railways) as a percentage of GDP. Source: Commission of the European Communities (2004) for the EU-15, IMAD (2004) for Slovenia.
[3] State aid (excluding aid to railways), excluding aid to agriculture and fisheries, as a percentage of GDP. Source: Commission of the European Communities (2004) for the EU-15, IMAD (2004) for Slovenia.
[4] Total state aid as a percentage of GDP minus the aid to transport (6.5% of total aid, see IMAD, 2004).

of the new member states, though Slovenia scores above average in terms of creditors' rights (low creditor's rights are assumed to hamper the willingness of creditors to give loans). The limited use of credit may have limited the number of efficient transactions by Slovenian citizens.

Furthermore, the use of credit is relatively limited

Table 11 gives some data on government expenditures and state aid as a percentage of GDP. Government expenditures give an indication of the size of the public sector, noting that a larger public sector is associated with lower productivity (once the public sector covers the main tasks of any government, *e.g.* defence *etc.*).[43] The

[43] Some authors prefer to use government consumption, which may be more appropriate as various investments of the government may be quite productive (*e.g.* infrastructure).

Government expenditures are somewhat above the EU average, state aid is quite a bit higher

data suggest that the share of government expenditures in GDP is somewhat higher in Slovenia than in the EU-15, and the other new member states for which we have data. Note further the remarkably low share of government expenditures in GDP in Ireland, Latvia and Lithuania.

Table 11 also gives ‘total’ state aid (which excludes aid to railways according to the latest definiton of the European Commission), and state aid excluding aid to agriculture and fisheries. Regarding total state aid, Slovenia is still quite far above the EU-15 average (no data are available for the other new member states). Furthermore, a much larger part goes to agriculture and fisheries than in the EU-15 on average. On a positive note, IMAD (2004) reports that in 2002 in Slovenia 74% of state aid not going to agriculture, fisheries and transport was for (the supposedly less distortionary) ‘horizontal’ objectives, compared to 59% in the EU-15.

7. Potential growth

We conclude with a calculation of the remaining growth potential from the 'rooms for improvements' we considered above. In Section 7.1 we start with the methodology. Next we consider the base projection of Jongen (2004), and then turn to the potential contribution to future growth rates by narrowing the remaining 'gaps' in inputs to production. The focus is on the average growth rate in real GDP per capita over the period 2002-2013.

7.1. Methodology

We make a projection of the growth in real GDP per capita using a projection for the growth in inputs and the production function. Consider again the expression for output we derived before in Section 5.1

$$Y_j(t)/P_j(t) = A_j(t)^{1/\beta} hc_j(t) h_j(t) ep_j(t) \varphi_j(t)^{(1-\beta)/\beta}.$$

We only consider the growth in GDP per capita in Slovenia here, and hence drop the subscript *j*. Furthermore, introduce the alternative 'employment-population' ratio *EP(t)* at time *t* as *EP(t)* ≡ *h(t)ep(t)*. Taking the derivative of the above expression with respect to time and dividing by GDP per capita gives the following growth rate for GDP per capita

$$g_{Y/P}(t) = \frac{1}{\beta} g_A(t) + g_{hc}(t) + g_{EP}(t) + \frac{1-\beta}{\beta} g_\varphi(t),$$

where g_x denotes the growth rate of *x*, $g_x \equiv X'(t)/X(t)$. For simplicity we convert the growth in inputs and output to average annual growth rates over the period 2002-2013 because we are primarily interested in how far Slovenia would get relative to the EU-25 by 2013.

7.2. Base projection of Jongen (2004)

Jongen (2004) considers a base projection for the inputs over the period 2002-2013, and also gives an extensive sensitivity analysis of this base projection.[44] Here, we suffice with a brief reiteration of the base projection for the inputs, and output.

Kraigher (2004) projects a minor annual decline of 0.02% of the population over the period 2002-2013. Since we are interested in the growth in GDP per capita up to the first digit, we ignore the small projected drop in the population. In the 'trend' projection of Kraigher (2004) employment is projected to grow slowly at 0.12% annually over the period 2002-2013. This average annual growth rate is comparable in size to the growth rate in employment over the past decade.

For human capital, Jongen (2004) uses a CES (constant-elasticity-of-substitution) weighted average of low- and high-skilled workers, including skill-biased

[44] Again, included in this volume.

technological change. We shall continue to use the CES-composite of low- and high-skilled labour for the calculation of the growth potential since Jongen (2004) cannot reject that there is skill-biased technological change in Slovenia and that low- and high-skilled workers are imperfect substitutes.[45] Jongen (2004) projects the CES-composite of human capital to grow at 2.3% annually, which is higher than over the past decade (though not unrealistic given the recent high enrolment rates in tertiary education).

Jongen (2004) projects the capital-output ratio to rise somewhat over the period 2002-2013, mainly driven by the presumption that real interest rates will still continue to fall for some time to come. The projected annual growth rate for the capital-output ratio for the period 2002-2013 is 1.05%. This is far below the 'catch-up' growth rate of the capital-output ratio calculated by Jongen (2004) over the period 1993-2002, 2.6%.

Finally, for TFP, Jongen (2004) 'simply' projects the growth to be somewhat lower than over the past decade, 0.5% annually. On the one hand, the closer Slovenia gets to the EU-25 TFP 'frontier' the slower the convergence rate might be. However, on the other hand, the analysis in Section 5 suggests that a sizeable gap in TFP remains in 2002 and further integration with the markets of the EU-15 may stimulate TFP growth (Ben-David, 2000).[46]

Again by using a value for the elasticity of output with respect to labour β of 0.7 we come to an annual average growth rate of 3.6% over the period 2002-2013. This is somewhat below the 4.1% over the period 1993-2002, but still impressive.

For completeness, without the growth in labour participation an increase in the level of education and further capital deepening the growth in output would be 2.3% because of the growth in TFP and the rise in the human capital index due to skill-biased technological change.

7.3. Closing the gaps

We next consider how closing the residual gaps in inputs in production might raise the growth in GDP per capita for the period 2002-2013, using the framework outlined above.

Regarding labour input, in Section 2 we concluded that the biggest room for improvement was the employment rate of older workers (55-64). To calculate the growth potential we need to know how many individuals we project will be aged 55-64 by 2013, and the size of the participation 'gap'. According to Kraigher (2004) there will be 291,000 individuals aged 55-64 in 2013. There is a participation gap of 14 percentage points as against the current EU-25 average, and 25 percentage points as against the Lisbon strategy target.[47]

[45] Above we focused on the average years of schooling as this is the most common in the literature. We did not use the CES-composite for the international comparison would require data on relative wages, which are not directly available.

[46] In the calculation of past TFP we did not make a correction for the change in average working hours. We may expect working hours per employee to fall as GDP per capita increases in the future. However, since the growth in GDP per capita is not projected to be that different from the past the 'bias' in TFP due to the change in working hours may be expected to be quite similar for the future as it was in the past.

[47] Again, see Economic Policy Committee (2003, Annex 2) for the quantitative targets of the Lisbon strategy.

Closing the participation gap of older workers with the EU-25 would raise projected per capita growth by some 0.2% relative to the base projection

Raising the participation of the elderly to these respective targets would increase employment by 41,000 and 73,000 persons, respectively. Assuming these individuals would have the same level of human capital as the average employee[48], this implies a potential annual growth in labour (and hence GDP per capita) of 0.4% and 0.7% over the period 2002-2013, for catching up with the EU-25 average in 2002 and the Lisbon strategy in terms of participation of the elderly respectively. However, in the base projection of Jongen (2004) the employment rate of older workers already rises to 32%. The additional growth potential of catching up with the EU-25 average of 2002 and the Lisbon strategy relative to this base projection is then 0.2% and 0.5%, respectively.

Next, we consider the remaining growth potential coming from education. In 2001 the share of tertiary educated workers was 17%, compared to 22% in the EU-15 and 37% in the US. Using our CES-composite of low- and high-skilled workers, catching up with the EU-15 average of 2001 by 2013 would imply an annual growth rate of human capital of 1.9%. Catching up with the US level of 2001 would imply an annual growth rate of human capital of 2.6%. Note that the difference in the growth rates in human capital is smaller than the difference in the 'education gaps' that are closed, as we keep skill-biased technological change the same in both scenarios.[49]

Reaching the goals of the education strategy of the Slovenian government would raise projected per capita growth by some 0.3% relative to the base projection

A comparison with the base scenario reveals however, that the share of tertiary educated workers in the EU-15 in 2001 is far below the 'trend' projection of Kraigher (2004) for this share in Slovenia in 2013, 29%. Hence the EU-15 average in 2001 is not a sensible target for Slovenia. Perhaps another useful target to consider is the target formulated in the education strategy of the government (Ministry of Education, Knowledge and Sports, 2004). Table 12 gives the transition rates between education classes, the share of tertiary educated and the average years of schooling in the 'trend' scenario of Kraigher (2004) and the scenario where the targets of the Slovenian government's education strategy are realised (in the 'translation' of Kraigher, 2004, of the education strategy). Table 12 also reports the averages for the 1995-2002 period and the levels for 2002, to add some perspective.

When the education strategy would be realised, the share of tertiary educated workers and average years of schooling in 2013 in Slovenia would be getting close to the US level in 2001 (see Table 2). Realising the education strategy would boost the annual growth in the human capital index from 2.3% in the base projection of Jongen (2004) to 2.6% over the period 2002-2013. Again the change in the growth of the human capital index is not that dramatic due to the fact that we keep the growth in skill-biased technological change the same in all scenarios. Furthermore, note from Table 12 that the realisation of the education strategy would require some drastic breaks from the trend (in part due to the unfavourable demographic composition of the population in Slovenia).

The room for further capital deepening is already filled in the base projection

Regarding the capital-output ratio, in Jongen (2004) we project a further increase in this ratio due to a projected further decline in real interest rates in Slovenia (at least relative to 2002). However, the closing of this 'room' is already incorporated in the base projection of Jongen (2004).

[48] The level of (formal) education may be lower for older workers, but they have more experience.

[49] The rate of skill-biased technological change may change in response to a bigger increase in the share of tertiary educated workers, as the invention and adoption of new technologies is directed more towards the high-skilled (see *e.g.* Acemoglu, 2002).

Table 12: **Transition rates between education classes, 'trend' and government education strategy, in %**[1]

	Average 1995-2000	2002	'Trend'	Education strategy of the government
			2013	2013
Unskilled to elementary	1.7	3.7	16.7	16.7
Elementary to lower vocational	0.6	0.3	0.2	1.5
Elementary to vocational	3.2	3.3	3.2	8.5
Elementary to higher secondary	5.4	7.0	9.7	14.9
Vocational to higher secondary	0.7	1.9	3.7	3.7
Higher secondary to non-university degree	0.9	0.5	1.1	4.4
Higher secondary to university degree	1.5	2.5	3.0	5.6
University degree to post-graduate	1.6	1.6	2.0	3.2
Share of tertiary educated (stock in %)	15.9	18.4	28.7	38.8
Average years of schooling (in years)	11.2	11.6	12.4	12.9

Note:
[1] Transition probabilities for the population aged 15-49, after 49 individuals are not expected to change education classes anymore, source: Kraigher (2004).

Catching up with average TFP in the EU-25 by 2013 would raise projected per capita growth by 3.4%

Finally, we turn to the growth potential for TFP. First, as an (admittedly unrealistic) exercise we may consider the impact of closing the gap with the EU-25 by 2013. Presuming that little if any of the gap is closed in the base projection of Jongen (2004)[50], closing the 23 percentage points gap would raise the annual growth rate of TFP over the period 2002-2013 from 0.5% to 2.9%, and the growth rate of GDP per capita from 3.6 to 7.0%. Clearly, this calculation is a mere exercise, but it still indicates the large growth potential that remains in terms of TFP.

Turning to some individual factors that might raise the growth in TFP, let us first consider R&D. We will consider two targets: a) catching up with the EU-15 level of 2001, 1.9%; and b) meeting the Lisbon strategy target, 3.0%, which is close to the US level in 2001 of 2.8%. To quantify the potential growth impact of reaching these targets we follow the past R&D as a stock of knowledge approach. We assume that in the base projection the R&D intensity would remain unchanged from 2002 onwards.

Suppose that knowledge originating from R&D, $Q_{R\&D}(t)$, is the sum of R&D expenditures in the past[51]

$$Q_{R\&D}(t) = \int_{-\infty}^{t} R\&D(s)ds.$$

Furthermore, suppose that there are two sources of TFP growth, R&D and ‘other’ (*e.g.* basic science *etc.*). Denote ‘other’ by $Q_{exo}(t)$, which grows at rate γ. Furthermore, suppose there are diminishing returns to knowledge input into production, and the elasticity of output with respect to knowledge from accumulated R&D investment is denoted by β_r. Specifically, suppose that output is given by

[50] For the EU-25 we do not decompose the projection into labour, human capital, physical capital and TFP growth due to a lack of projections for the inputs. In Section 5 we found that Slovenia was able to close only a small part of the TFP gap over the period 1990-2002.

[51] We assume no depreciation of this knowledge.

$$Y(t) = Q_{exo}(t)(Q_{R\&D}(t))^{\beta_r}(hc(t)E(t))^{\beta}K(t)^{1-\beta}.$$

Given the assumptions above we have $g_A = \gamma + \beta_r g_{Q,\,R\&D}$. From the production function we have $\beta_r = (dY(t)/dQ_{R\&D}(t))(Q_{R\&D}(t)/Y(t))$. Substitution into the growth rate of TFP gives $g_A = \gamma + (dY(t)/dQ_{R\&D}(t))\ (R\&D(t)/Y(t))$. Hence, we have expressed growth in terms of the share of GDP spent on R&D, the 'rate of return' to R&D given by $dY(t)/dQ_{R\&D}(t)$, and a residual trend γ. We know the share of R&D, all we need is a rate of return to obtain a guestimate for the impact of a higher share of R&D on output growth.

Typically, market failures feature prominently in R&D.[52] The consensus view appears to be that empirically the net effect is too little R&D (*e.g.* Jones and Williams (1998) suggest that R&D in the US is about four times lower than the social optimum). Therefore, studies typically find returns to R&D much higher than on other types of investment (probably also after correcting for the risk profile of R&D expenditures). For example, Nadiri (1993) suggested a direct return of 20%-30% and an average social return of about 50% (significantly above the return on other investment opportunities). More recent studies typically find lower social rates of return, but they may still be an impressive 30 percent. To be conservative we take 10% as the lower bound and 30% as the upper bound.[53]

Reaching the Lisbon strategy target for R&D intensity might raise projected growth in GDP per capita by some 0.2-0.6%

In 2001, spending on R&D in Slovenia was about 1.6%. Raising the share to the EU-15 level of 2001 of 1.9% would increase the annual growth in TFP by 0.03% and 0.09%, for the lower and upper bounds of the social rate of return, respectively, in turn raising annual per capita growth by 0.04% and 0.13%, respectively. Raising the R&D intensity to the Lisbon strategy target would increase TFP growth by 0.14% and 0.42%, for the lower and upper bounds of the social rate of return, respectively, thereby raising annual per capita growth by 0.2% and 0.6%, respectively.

We conclude our analysis of the growth potential of R&D with a cautionary note. Apart from the relatively dramatic changes that would be required to almost double expenditure on R&D, the quality indicators in Table 6 suggest that the 'productivity' of R&D in Slovenia may be relatively low. Hence, in terms of both quantity and quality, the above back-of-the-envelope calculations should be taken as an upper bound on the growth potential coming from R&D for the period 2002-2013. Furthermore, for this to raise the average annual growth rate over the period 2002-2013 the R&D intensity would already have to be at the target level from 2003 onwards.

The impact of other factors on TFP growth is more difficult to quantify

Unfortunately, for most of the other factors we considered in Section 6 it is relatively hard to quantify what closing a particular 'gap', for example in the stock of inward FDI, would imply for the potential growth in GDP per capita. Let us conclude with a very tentative analysis of the impact of the institutions related to the flow of jobs and workers. In Jongen (2004) we find that the growth rate of skill-biased technological change is substantially lower in Slovenia, about 1.7% per annum,

52 The surplus extraction problem for a monopolist gives rise to too little R&D (does not reap all the consumer surplus). Positive intertemporal spillovers ('standing on shoulders') also give rise to too little R&D. However, creative destruction (private profits of invention are higher than social profits) and stepping-on-toes (duplication of research) give rise to too much R&D. Empirically, rates of return appear to be high, suggesting too little R&D overall, see *e.g.* Jones and Williams (1998).

53 The rate of return will fall as the knowledge stock rises relative to output. However, note that the rates of return used here are from the US, which has above-average expenditure on R&D as a % of GDP. Hence, the rates of return in the analysis here, for Slovenia, might still be considered 'conservative'.

Table 13: **Growth potential, average annual growth rates, in %, 2002-2013**

	Labor	Human capital	Capital-output ratio	TFP		GDP per capita
No growth in labor, education and capital-output ratio	0.0	1.6	0.0	0.5		2.3
Base projection of Jongen (2004)	0.1	2.3	1.1	0.5		3.6
Additional room for improvement relative to base projection of Jongen (2004)						
Employment rate of workers aged 55-64 to EU-25 (2002) level	+0.2	-	-	-		+0.2
Employment rate of workers aged 55-64 to Lisbon strategy target level	+0.5	-	-	-		+0.5
Reaching education strategy targets	-	+0.3	-	-		+0.3
Closing the TFP gap with the EU-25	-	-	-	+2.4		+3.4
R&D/GDP to EU-15 (2002) level	-	-	-	+0.0-0.1 [1]		+0.0-0.1 [1]
R&D/GDP to Lisbon strategy level	-	-	-	+0.1-0.4 [1]		+0.2-0.6 [1]
Skill-biased technological change to int. level	-	+1.6	-	-		+1.6

Note:
[1] Results are for the lower (0.10) and upper (0.30) bound on the social rate of return to R&D, respectively.

than typically found in studies on skill-biased technological change, about 3.0% per annum (see *e.g.* Katz and Autor, 1999). When the rate of skill-biased technological change rises to the international pace of 3.0% per year after 2002, the human capital index would grow at 3.9%, raising the growth in GDP per capita by 1.6%. This is merely to indicate that, in terms of human capital, raising the pace of skill-biased technological change could have a large pay-off in terms of GDP per capita (this would increase wage differentials between low- and high-skilled workers though, at least insofar as the higher wage differentials will not stimulate an additional increase in the share of high-skilled workers).

Table 13 gives an overview of the growth potential based on the various rooms for improvement. In Sections 2-4 we saw that Slovenia is quite close to the EU average in terms of labour participation, average years of schooling and the capital-output ratio. Still, hiding behind the averages, some room is left regarding the labour participation of the elderly and the share of the tertiary educated. Yet closing these gaps would raise the growth rate in GDP per capita by less than a percentage point over the base projection. In Jongen (2004) we find that the annual growth in GDP per capita over the 2002-2013 period would have to be 1.3% higher than the base projection of Jongen (2004) to catch up with the EU-25 in terms of GDP per capita by 2013. Hence, higher labour participation and education are not enough to achieve this goal. For this, TFP growth would have to be increased. Fortunately, Table 13 shows there is still a lot of growth potential as far as TFP growth is concerned. In Section 6 we considered some factors that may ‘explain’ the residual TFP gap. Unfortunately, for most of them it is relatively hard to quantify the impact on potential output growth.

8. Concluding remarks

Slovenia enjoyed remarkable growth in real GDP per capita over the period 1993-2002 period, on average 4.1% per year. In recent years growth has slowed down considerably, but this is presumably largely driven by the business cycle downturn.

Although the Slovenian economy has grown rapidly, in some respects there is still a lot of room for improvement. Compared to the EU-15 the labour participation of older workers is exceptionally low, the share of tertiary educated workers is low, and interest rates are still relatively high (at least they were at the end of 2002). As a result, for the period up to 2013 we still project growth rates substantially above the EU level, 3.6%.

The base projection of Jongen (2004) narrows down a lot of the room regarding participation, education and capital deepening. Still, a sizeable gap in 'total factor productivity' relative to the EU remains. Hence, over and above the base projection there remains great potential for growth from factors that raise TFP growth. The future of real GDP per capita growth in Slovenia still seems bright.

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