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CAPITAL STOCK ESTIMATION IN HUNGARY: A BRIEF DESCRIPTION OF METHODOLOGY AND RESULTS

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Abstract

The capital stock in Hungary was estimated using two approaches: one based on the historical time series of investments and the other based on direct survey data. The two approaches resulted in significantly different levels of net capital stock estimations: the level estimated by cumulating investments is approximately 50 percent of the level calculated from the survey data. Although the historical investment series is considered to be less reliable, it was found that the investments-based estimation provides more acceptable results by international standards.

During the estimation, several issues emerged that strongly relate to the transition process, and therefore have not been discussed in the "classical" literature on the capital stock. We found no reliable information on how to estimate the one-off depreciation of non-competitive capital assets that were activated before the 1990s and also found it difficult to give assumptions for the changes in service life before and after the transition period. However, the sensitivity analysis showed that the alternative assumptions lead to only slight differences in the estimated accumulation path of the capital stock, and consequently strengthened the hypothesis that our results were quite robust. We also made a crosscheck using the growth accounting framework, and found that the estimated capital stock generated a TFP dynamics that is in accordance with international experience.

Contents

1. Introduction

Measurement of the capital stock is problematic even in developed countries. The basic dilemma of how to capture the changes in asset value is still quite formidable. Assets lose their value by ageing, i.e. they lose efficiency and yield fewer productive services over time. But the value of an asset also declines due to obsolescence, as new and more developed equipment appears in the market, which is more suitable for production. These changes are hardly monitored by firms and even less efficiently measured at the national level. The difficulties related to capital stock measurement have been a focal point of international statistics for years, and the OECD recently published a manual (OECD 2001) to give practical guidance for estimation.

In addition to the problems above, estimating capital stock in a transition economy is even more difficult for two reasons: namely the heterogeneity of the stock and the lack of reliable statistics. During market restructuring a substantial portion of old capacities becomes obsolete in these economies, while on the other hand high-tech capital accumulates rapidly. Not much is known about the scale and characteristics of the two types of capital, the average service life and depreciation pattern of the different types of assets. In addition to the turbulent economic environment, the transition of the statistical system itself is a serious cause of estimation bias, and in some countries even the data on recent investments is considered unreliable.

In the case of Hungary the problems resulting from lack of data are relatively less severe. As part of a wider project the Hungarian Central Statistical Office (HCSO) published preliminary data on the end-1999 gross capital stock of the corporate sector last year. The estimation is based on a survey conducted according to international standards with the assistance of Eurostat. The HSCO also compiled an unofficial series of historical investments in order to provide a crosscheck of its survey-based estimates. The formation of these two new data sources was one of the main incentives behind the current analysis.

Motivation also came from the need for supply side modelling in Hungary. The European Commission urges all acceding countries to calculate potential output by a production function approach, and although it allows for a certain degree of flexibility in adopting EC methodology, capital stock is a vital element in such estimation.

On this note, we calculate capital stock figures using the perpetual inventory method (PIM). The structure of the paper is as follows: in Section 2 we give a brief description of the PIM and the different approaches associated with the methodology. In Section 3 we sum up the literature on the PIM with a special focus on capital estimation in transitional countries and Hungary. Sections 4 and 5 present the data and the main assumptions used during the analysis. As we were uncomfortable with unreliable input data and the lack of information on capital heterogeneity, we examined the robustness of our estimates and applied several crosschecks and a sensitivity analysis. In Sections 6 and 7 we examine how our results parallel with the international experiences, and also discuss the sensitivity of the estimates to alternative assumptions. Finally, the capital stock series were used to calculate TFP growth rates using a production function with changing factor shares. The results of this exercise are compared to the dynamics seen in other countries. In Section 9 we summarize our main findings that are valid in the context of transitional countries.

2. Applications of the PIM

The most commonly used method for calculating the stock of capital is the perpetual inventory method (PIM). Based on the PIM, the gross and net capital stock of a given asset is estimated as follows:

Gross capital stock: $$K_t^B = K_{t-1}^B + I_t^B - S_t = \sum_{j=0}^{L\max} g(j) * I_{t-j}^B \qquad (1)$$

Net capital stock: $$K_t^N = K_{t-1}^N + I_t^B - D_t = \sum_{j=0}^{L\max} g(j) * I_{t-j}^B * d(j) \qquad (2),$$

where K_t^B reflects the gross capital stock value at time t

I_t^B gross capital formation at time t

S_t discard at time t

D_t discard and depreciation at time t

L max asset service lifetime

$g(j)$ survival function

$d(j)$ depreciation function.

According to the formulas above, there are two ways of applying the PIM.

If an initial capital stock is available, net capital stock for subsequent periods can be calculated by considering the net effect of additional gross fixed investments and the discard / depreciation of existing capital (the first right-hand-side-formula in equation (2) above). The determination of the depreciation – discard term (D_t) requires assumptions for the average service life of a given asset, and for the retirement and depreciation pattern it follows. In the rest of this paper we will refer to this type of PIM application as the *initial capital approach*.

Although the initial capital approach is extensively used in the practice of developed countries, this application of the PIM is seriously constrained in transitional countries, due to lack of reliable data on the initial capital stock. Initial capital estimates in transitional countries mostly rely on information from corporate accounting, which is considered inadequate for capital stock calculations for three reasons. First, accounting data usually differs from real economic conditions as it is strongly affected by tax regulations. Secondly, capital in the books is evaluated at historical prices, which means that the data has no uniform price base, as it is simply an aggregation of assets at different prices. And finally in transition economies the transformation of the corporate sector and the privatisation of state companies led to such a turbulent flow of assets that is hardly monitored by book values. Consequently, using initial capital estimates that are based on accounting data results in a significant estimation bias in transitional countries.

If initial capital stock data is lacking, the PIM provides an alternative solution as well. As capital stock equals the sum of all past investments that are still in use (the second right-hand-side-formula in equations (1) and (2) above), we may use the PIM as a tool for building a so-called vintage model (*vintage model approach*). The vintage model reckons the investments from previous years as the different vintages of the current capital stock. To estimate a gross initial capital stock value an assumption on the average service life of the given asset is needed in order to determine the starting year of the aggregation. Besides that, to calculate net values of capital, assumptions on the retirement and depreciation patterns are also required.

As the average service lives of buildings exceed 50 years one needs to have a historical series of investments to create a vintage model. Fifty-year investment series with a uniform methodological framework are hardly found even in the statistics of developed countries. In case of the transitional countries the data are less reliable, with a structural break at the beginning of the 1990s, and with values possibly distorted by artificially set prices prior to transition. However, the estimation bias resulting from data unreliability is cushioned by the fact that the effect of past investments on current net capital stock is shrinking due to the ageing and obsolescence of assets over time.

3. Literature

There is an extensive body of literature on the subject of capital stock estimation in developed countries, but only very few attempts have been published on calculating estimates for transitional countries.

In developed countries official capital stock statistics are provided by the central statistical offices. The method used is similar to that described previously: they conduct wealth surveys with different time-spans and use the PIM to calculate the capital stocks in the interim period. A detailed description of the OECD countries' practice is given in OECD (1992).

On the other hand, recent efforts to analyse the sources of growth across countries has given impetus to a new method of capital stock estimation, the standardised estimation method. The standardised estimation method was introduced by Maddison (1993), who claimed that official estimates were inadequate for comparative analysis due to the high variance in service life assumptions.[1] He made gross capital estimations for six developed countries by using the vintage model approach and relying on historical investment series. The novelty of Maddison's standardisation procedure is to assume standardised asset lives for all the countries under review, i.e. 39 years for non-residential structures and 14 years for machinery and equipment.

Besides giving comparable estimates the standardisation method has further advantages compared to the official figures. It permits one to push back the time series further than official measures, and above all it enables one to experiment with and test the sensitivity of the results to alternative assumptions. In view of these advantages the practice of standardising capital stock measures has spread rapidly in recent years (Hofman (1992), O'Mahony (1992), Timmer and van Ark (2000), D'Adda and Scorcu (2002)).

For developing countries, Nehru and Dhareswar (1993) set up a comparable capital stock database. For lack of historical investment series they used alternative techniques to estimate the initial stock of capital, finally finding the Harberger-approach to be the most effective tool.[2] However, this approach is based on the assumption that the capital-output ratio is constant, a statement which is empirically disputable in the long term. Nehru and Dhareswar calculated net values using a geometric pattern of decay, which has the advantage of giving both survival and depreciation weights (*g(j)* and *d(j)*) at the same time.

The literature on capital stock estimation in transitional countries is quite limited due to the lack of data. The official estimates of statistical offices are mainly based on corporate accounts, but the details of the calculations are unavailable to the public in most countries.

Comparable calculations for the CEECs were made by the IMF. Doyle, Kuijs, and Jiang (2001) followed the initial capital stock approach, using the 1985 capital stock of Hungary as a benchmark. For the Slovak Republic and Slovenia they assumed a similar

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[1] Maddison shows that the average life assumption for non-residential buildings is 57 years in Germany, 39 years in the USA, whereas in the UK it is 66 years. For machinery and equipment these numbers are 14 years for Germany and the US, whereas it is 25 years for the UK (Maddison (1992), p. 138).

[2] The approach applied by Harberger (1978) is built on the accumulation equation:

$$(K_t - K_{t-1}) / K_{t-1} = -\delta + (I_t / K_{t-1})$$

using the assumption that the capital-output ratio is constant the above equation can be rewritten as:

$$K_{t-1} = I_t / (g + \delta)$$

The initial capital stock is derived from the above equation with data on growth, depreciation and investments.

capital-output ratio as for Hungary, for Poland the ratio was set 10 per cent lower, whereas for the Czech Republic it was assumed to be 10 percent higher. To derive the subsequent capital stock series in each country, the officially reported fixed investment data from the national accounts were added to the base period capital stock, and an allowance was made for depreciation. The assumed rate of depreciation was 8 percent in all cases except Poland, where the rate was chosen to be 5.5 percent due to the relatively large share of buildings in the stock. The one-off drop in obsolete capital was estimated to be around 35 percent in all countries except for the Czech Republic, where the 1998 official capital data allowed for only a 20 percent loss in capital. The calculated net capital-output ratios fall in the range of 2 and 3 for 1999. Although the above assumptions are considered consistent, the chosen benchmark of the Hungarian capital stock is inadequate data and leads to estimation bias.

The problem with the pre-1990 Hungarian capital figures is similar to those of other transitional countries: the data are based on corporate accounting and do not employ a common price base. The most comprehensive and prudential estimation on the capital stock of Hungary by Darvas and Simon (2000) found an alternative technique to tackle the absence of reliable capital statistics. They used official investment series starting in 1980 and estimated the initial level of the capital stock in 1980-89 based on a TFP growth assumption in a Cobb-Douglas production function during this period, and followed the PIM for subsequent years. The calculations were based on the assumptions of a linear depreciation pattern, an average depreciation rate around 7 percent and a 21 percent one-time loss in capital. They found the non-residential capital-output ratio to be around 1.7-1.8 for most of the 1980-1998 period which they analysed.

During the recent calculation of capital stock in Hungary we intended to use a method that was free of assumptions regarding any particular shape of the production function. The major impulse behind the calculations was the compilation of two new time series, i.e. the end-1999 gross capital stock of the corporate sector based on a survey and a historical series of investments. The two types of data source made both the initial capital and the vintage model approach attainable in Hungary. However, during the analysis we found that the survey data seem to overestimate the capital stock. A brief description of the estimates based on the survey data, and arguments for using the historical investment series is given in Appendix 1.

For the reasons above, in this paper we estimate the capital stock using the vintage model approach and data of the historical investment series. The procedure we follow is quite similar to that proposed by Maddison. The calculations are made at a two-digit disaggregation level and the average service lives are basically taken from the OECD practice. For estimating net values we used a geometric pattern of decay. The one-off drop in capital was estimated from a Cobb-Douglas production function with the assumption of a zero TFP growth for the period 1990-92. The data, the assumptions and the results are presented in detail below.

4. Data

According to OECD methodology capital stock includes goods that are durable, tangible, fixed and reproducible. This definition excludes immaterial assets, inventories, and land from capital stock. In addition, as we intended to estimate non-residential capital stock, residential buildings are also excluded from the calculations.

Our *vintage model approach* uses the long historical investment series provided unofficially by the HCSO, at constant prices in a breakdown by categories (non-residential building and machinery) and by industries. The input of the data is the official series of investments put into operation at current prices, based on official data back to 1959. For the previous years the series is built on information from the 1968 wealth survey. To transform the current values to 1999 constant prices the investment price indices were used. There has been no official data on investment prices by industries since 1990, so the HCSO applied its own estimates. The

poor quality of the investment price data is one of the main shortcomings of the historical investment series.[3]
Using the unofficial investment data instead of the official data has the advantage of estimating the capital at a more disaggregated level, with more refined service life and depreciation assumptions. However, after determination of an average service life for the whole economy, estimation with the official data gives broadly similar results to those made with the disaggregated unofficial data. The pros and cons of using the official versus the unofficial series and the changes in results are presented in Appendix 2.

5. Assumptions

The PIM requires assumptions on service lives (L_{max}), and on the shape of survival (*g(j)*) and depreciation functions (*d(j)*). In addition to this, we also made an assumption on the one-off drop in capital in the early 1990s, as a result of the loss of productive potential during the market restructuring. A brief summary of our assumptions is given in Table 1.

Table 1. Baseline assumptions

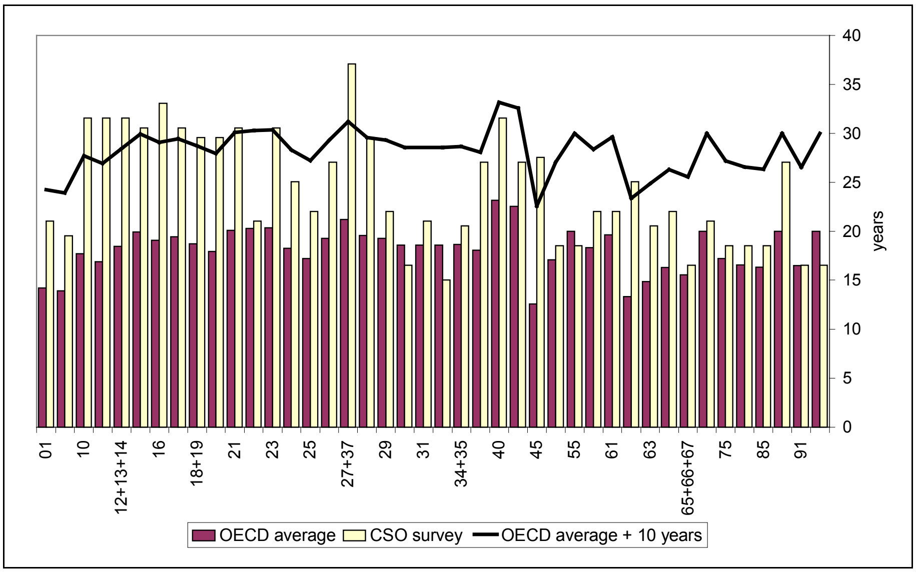
	Period	*Year of activation*	*Category*	*Baseline*
Average service life (years)	Before 1991		Buildings	45
			Machin. and other	18
	After 1991		Buildings	45
			Machin. and other	18
Depreciation rate (%)	Before 1991		Buildings	2,0
			Machin. and other	9,2
	After 1991	Pre-1991	Buildings	3,4
			Machin. and other	18,3
		Pro-1991	Buildings	2,0
			Machin. and other	9,2
One-off drop (%)				25

Assumption on average service lives
One of the most important elements in the PIM estimation is the choice of service lives. Service lives cannot be observed directly and, above all, are supposed to change over time. In the OECD countries' practice basically there are three sources of service life estimations: tax-lives, company accounts and questionnaires. In Hungary, the HCSO collected service life data in its survey, but considered the data extremely unreliable and did not publish it officially. Consequently, as a baseline we used the average of the service lives of 12 OECD countries, which is available in a breakdown by branches (OECD 1992).
The service lives from the HCSO survey tend to be higher than the OECD averages with the exception of newly established industries of machinery, and commercial and financial services (see Chart 1 and Chart 2). Albeit unreliable, the data is considered to be indicative: service lives in Hungary are supposed to be higher than the OECD average, as a significant part of the obsolete capital has still not been discarded. Although we insisted on our baseline for its simplicity, we checked for the sensitivity of the results on alternative assumptions. We

[3] A detailed description of the historical time series of investments is given by Imre (2002)

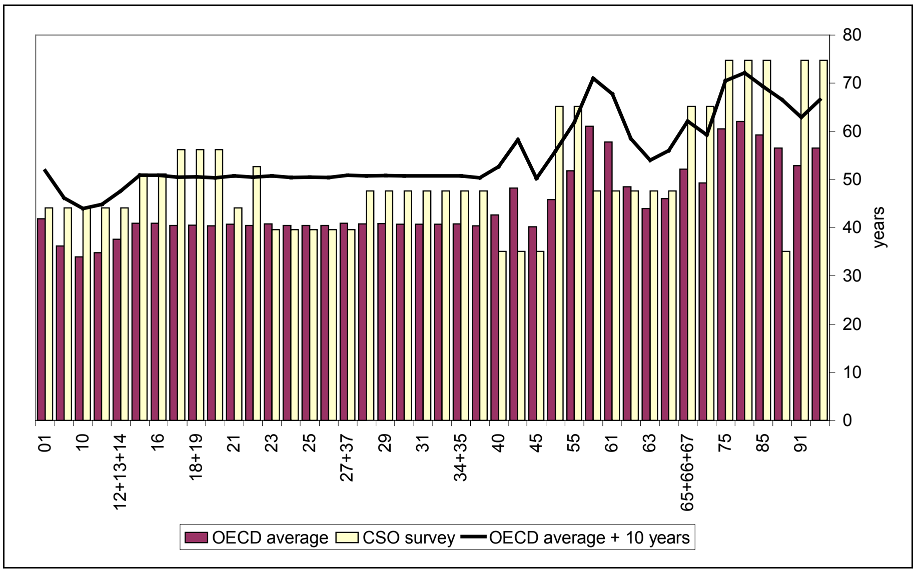
made calculations using service lives that were 10 years longer than the OECD average; the results are presented in Section 7.

Chart 1: Average service life assumptions for machinery and equipment, and for the category of other investments by industries



The x-axis contains the 2-digit-NACE code of industries

Chart 2: Average service life assumptions for buildings by industries



The x-axis contains the 2-digit-NACE code of industries

Assumption on the shape of survival functions and depreciation patterns

OECD countries use several kinds of mortality and survival functions. For mortality functions the simultaneous exit and different types of bell shaped functions (Winfrey, Weibull and the lognormal function) are the most frequent.

The depreciation functions in most OECD countries follow a linear or a geometric pattern. The geometric pattern is proposed by the Bureau of Economic Analysis (BEA) in the US, and based on prices of used assets.(Fraumeni (1997)) The formulation of the BEA's depreciation function is as follows:

$$d(i) = \left(1 - \frac{DBR}{L_{avg}}\right)^i,$$

where L_{avg} denotes the average service life, *DBR* stands for the so called Declining Balance Rate, and *i* represents time. The main advantage of this pattern is that it takes into account both the mortality and depreciation effects, i.e. it uses weights, where both *g(j)* and *d(j)* are considered. To avoid the difficulty of using different depreciation and mortality functions we chose this pattern in our estimation. According to the BEA's recommendation we applied a DBR of 1.65 for machinery and equipment and 0.91 for buildings, respectively.

In the case of depreciation functions we also experimented with different patterns, namely with linear depreciation, the depreciation suggested by Ross and the Vogels depreciation function.[4] With these depreciation functions the simultaneous exit concept of mortality has been augmented. The alternative patterns do not provide significantly different results, as will be shown later.

Assumptions on the one-off drop in asset efficiency

As a result of market restructuring a substantial loss in the productive potential of the Hungarian economy occurred in the early 1990s. Capital equipment used to produce the lower-quality products traded within the CMEA had to be discarded, as it was inadequate to produce the higher-grade products demanded by developed market economies.

The scale of this one-off drop in capital efficiency and discard is difficult to measure, and as it is a characteristic of economies in transition there is no extensive discussion of it in the "classical" capital literature. Generally, the most common way to estimate the one-off drop in capital is using a growth accounting framework with assumption on the production function and the TFP residual. The IMF estimated a 35 percent drop in capital efficiency for Hungary in 1991, calculated as a sum of a 20 percent loss due to the collapse of CMEA trade and an additional 15 percent due to the so-called "disorganization" effect (IMF (1999)). The former was estimated in a growth accounting framework, while the latter was a less evident expert judgement.

In our estimate we focused purely on those effects that are quantifiable. We used the growth accounting framework for the period 1990-1992. Under the assumption of a Cobb-Douglas production function with a 0.6 labour income share, and zero TFP growth, the 15 percent drop in output corresponds to a 25 percent decline in the capital stock. Although TFP growth could well be negative in that period, we kept the non-negative growth assumption as an extreme case of capital deterioration. To give consideration to the IMF estimates the alternative assumption of a 10 percent higher one-off drop has also been examined. The results are presented in Section 7.

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[4] The depreciation pattern suggested by Ross has the form of $d(i) = 1 - \frac{i}{2L_{avg}} - \frac{i^2}{2L_{avg}^2}$, while the Vogels depreciation function is given by $d(i) = 1 - \frac{1.2i}{L_{avg}} + \frac{0.4i^2}{L_{avg}^2}$ where *Lavg* denotes the average service life, and *i* represents time. The former pattern results in slightly progressive depreciation and is especially recommended for administration buildings. The Vogels depreciation is an empirically-determined pattern, which results in a slightly degressive depreciation. With this pattern the asset is not written off totally in accordance with the empiric that the value of buildings does not drop below 30% of the original construction cost.

The exact shape of these functions was taken from Böhm, et al. (1998).

6. Results

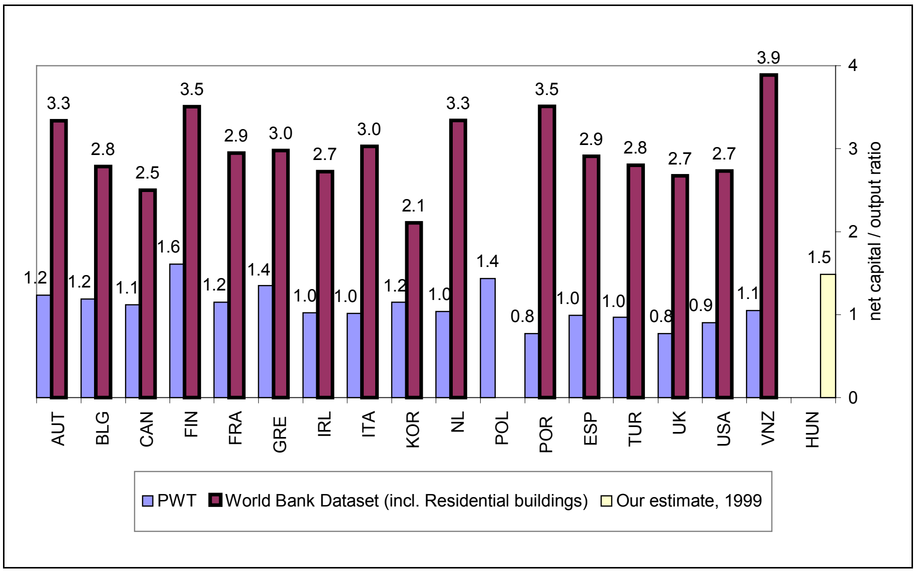
The final net capital stock estimates for 1980-2001 are presented in Table 2. The ratio of the calculated net capital stock to output is 1.5, which is slightly lower than the previous estimates of 1.7 and 2 by Darvas and Simon (2000) and Doyle et al (2001), respectively.

To check on the validity of our results we made an international comparison. The comparison of international capital stock data cannot be made on the basis of official data, due to dissimilar service life and depreciation assumptions. According to the literature there are two main databases that contain standardised capital stock data for both developed and developing countries: the Penn World Tables (PWT) (Summers and Heston (1991)) and the World Bank dataset (Nehru and Dhareswar (1993)).

The net capital-output ratios estimated for Hungary using the *vintage model* approach is somewhere in the range of international data (see Chart 3). However, the capital-output ratios of the two international datasets are quite different, and move in the wide interval of 0.8-3.9. The difficulty of comparing our results with data from these databases stems from the fact that these statistics are calculated by methodologies different from ours, or are based on a different definition of capital stock.[5]

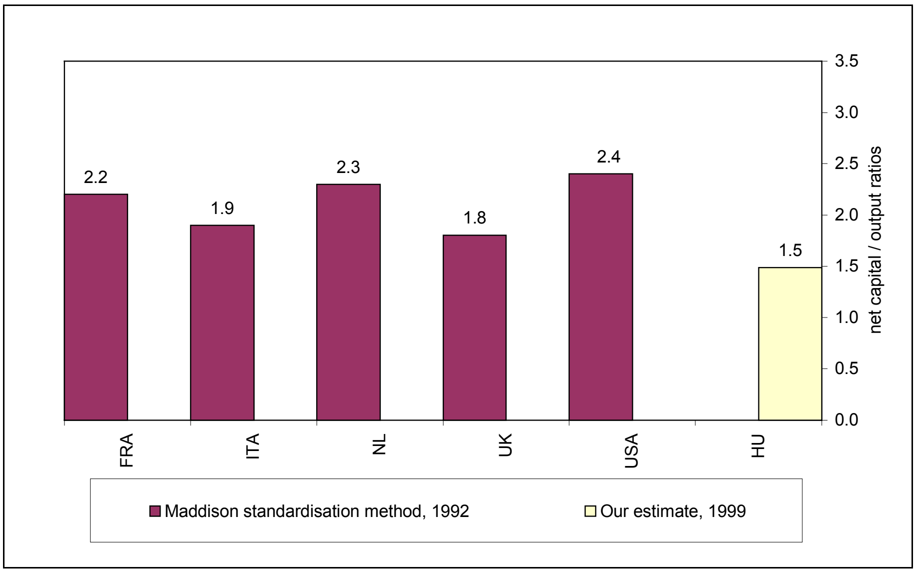
Although it focuses on developed countries, the Maddison standardisation procedure is quite similar to ours and uses the same definition of non-residential capital. We assumed that the difference between the standardised service lives applied by Maddison and those used by us is not significant enough to prevent a valid comparison. Comparing our results with the ratios given by Maddison, we see our estimates to be lower than ratios of developed countries. According to the vintage model approach, the capital-output ratio for Hungary is about one-half of the US ratio, and two-thirds of the UK ratio (see Chart 4). If we accept the theoretical requirement that transitional countries should have smaller productive capital / output ratios than developed countries due to a high share of obsolete capital, then the estimated 1.5 per cent capital / output ratio for Hungary seems reasonable by international standards.

Chart 3. Comparison of our estimate with capital / output ratios from the PWT and the World Bank dataset (1980-1990 average)



[5] PWT uses investment output ratios to estimate the initial stock of capital, while the World Bank database capital stock includes residential buildings, which differs from our definition. The inclusion of residential buildings in our estimates would increase the calculated Hungarian capital ratio by 0.3-0.5.

Chart 4. Comparison of our estimate with capital / output ratios calculated by the Maddison standardisation method



Source of international data: Maddison (1992)

7. Sensitivity analysis

As mentioned in Section 5, we examined the sensitivity of our results to all the major assumptions of the analysis. Generally, we carried out a sensitivity test using alternative assumptions for average service lives, for depreciation pattern, and the one-off drop in capital efficiency.

According to our results, the sensitivity of the capital stock estimations can be considered low (Table 2). For example, assumption of a 10-year-longer service life would result in only a 0.1 point higher capital-output ratio. The use of alternative depreciation patterns would decrease the ratio by 0.1-0.14, and a 10 percent higher one-off drop in capital efficiency would cause less than a 0.1 point change in the ratio. All in all, if one assumes a 10-year-longer service life, a linear depreciation pattern and a 36 percent one-off loss in efficiency one ends up with a 0.12 point lower capital-output ratio of 1.37.

Table 2. Sensitivity analysis

	Baseline	*Alternative*	*Sensitivity (difference from baseline ratio)*
Average service life (years)	OECD average	Longer service lives	
Buildings	45	55	On average: +0.10
Machinery and other:	18	28	
Retirement and depreciation functions	Geometric depreciation	Linear	-0.14
		Progressive (Ross)	+0.0
		Degressive (Vogels)	-0.11
One-off drop (%)	26	36	-0.08

8. Growth accounting

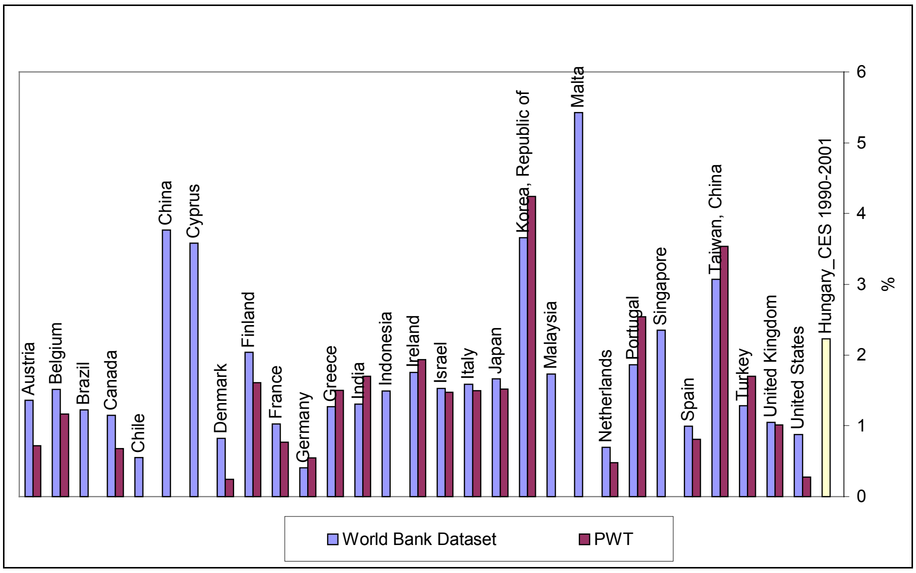
The capital stock estimates presented in the previous sections can be used in a growth accounting exercise. As a final check on the validity of our estimates we examined whether our results from the growth accounting framework for the "Solow residual" would prove to be acceptable by international standards. During the analysis we assumed a CES production function with a neutral technological change. The formula we used was the following:[6]

$$\dot{a}_t = \dot{q}_t - \frac{w_t}{y_t} * \dot{l}_t - \frac{r_t}{y_t} * \dot{k}_t \ ,$$

where dots stand for changes in logs, *w/y* is the share of labour costs in income, and *r/y* is the profit share. The time-varying factor shares were calculated using National Accounts Data.

[6] The formula is proposed by Solow (1957). It is derivable from a production function, using time derivatives and under the assumption of competitive factor markets, where marginal products equal factor prices.

Chart 5. TFP growth in Hungary (1990-2001) and in the world (1970-90)

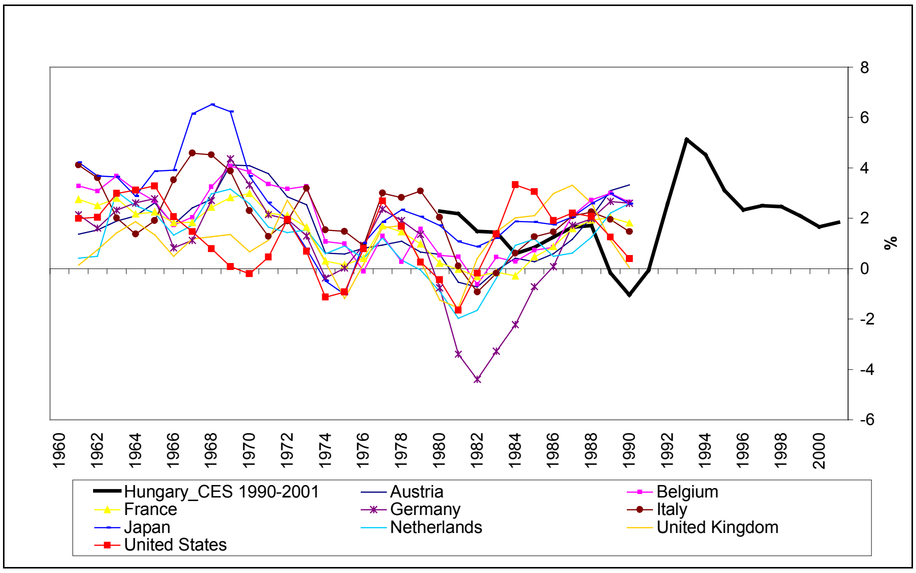


Source of international data: Nehru-Dhareswar (1994)

The "Solow residual" gained from the equation above showed 2.2 percent annual growth in the period 1990-2000. That rate is in accordance with international experience (Chart 5). If we compare our results with the TFP dynamics of different regions we find that Hungarian TFP growth in the 1990s was around the rate of the NICs. The TFP in Hungary grew faster than in the Western Countries, and close to the rate experienced by the Southern European countries during the 1970s (Charts 6 - 8). These results conform to our assumptions about the supposed sources of domestic growth.

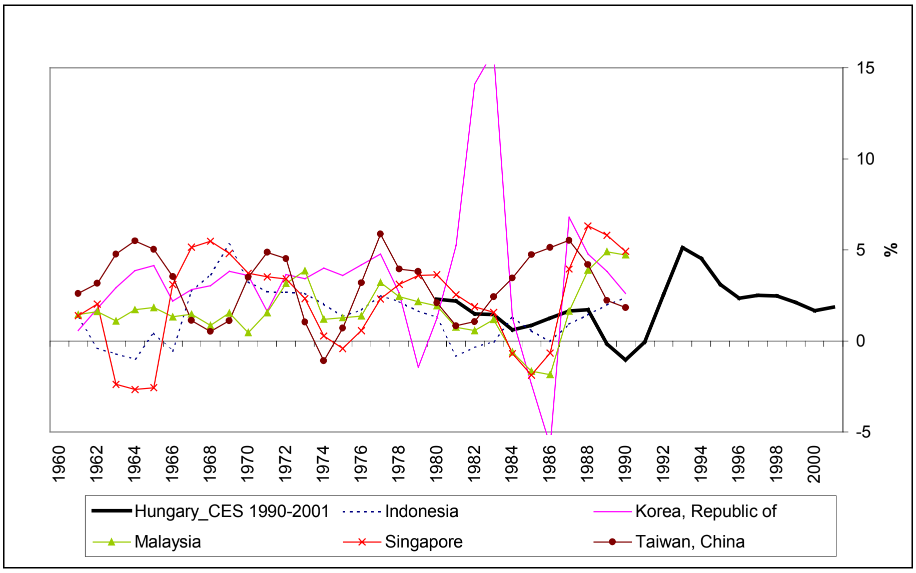
A specific feature of economic transition in Hungary is the very strong TFP growth in the period of 1991-95. This is a result of a negative labour contribution due to the sluggish labour market restructuring, which led to a continuous decrease in employment until 1998. With a modest deepening of capital, the significant difference between the growth rates of output and employment is explained by the "residual", implying a productivity gain as high as 7 per cent until 1994. In recent years the contributions of the various factors to overall growth has become somewhat more balanced, and the rate of TFP growth decreased to around 2 percent due to a pick up in the contribution of labour force. The detailed analysis of sources of growth however needs a further investigation and may be a topic of a future research.

Chart 6. TFP growth dynamics in Hungary compared to Western countries



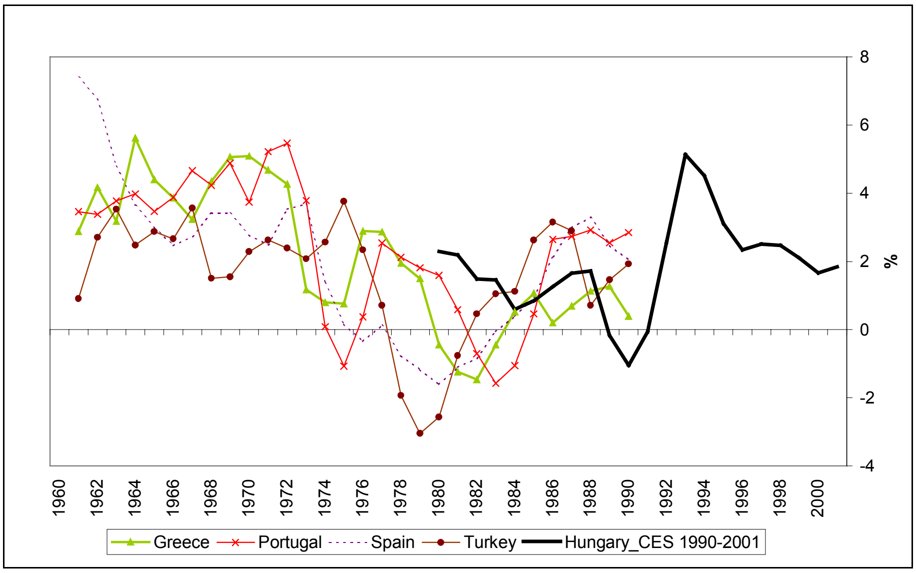
Source of international data: Nehru-Dhareswar (1994)

Chart 7. TFP growth dynamics in Hungary compared to NIC countries



Source of international data: Nehru-Dhareswar (1994)

Chart 8. TFP growth dynamics in Hungary compared to South European countries



Source of international data: Nehru-Dhareswar (1994)

9. Conclusion

Estimating capital stock in a transition economy is a difficult task for several reasons. First, there is a lack of reliable data. Using the PIM, one either needs data on the initial capital stock, or a historical investment series. In most countries neither of those datasets are available, and even if they are available they are considered to be highly unreliable. In the determination of current capital stock levels, however, historical investments play a marginal and shrinking role. For example, the ratio of investments that were activated before 1990 in the 1999 net capital stock is 40 percent, whereas the ratio of those activated before 1980 is only 15 percent.

Another difficulty is the fact that there is a lack of information on service lives and depreciation patterns as well. Although service lives of different assets are supposed to be longer than in the OECD countries as a result of surviving obsolete capacities, the exact difference is not known. Furthermore, not much is known about the discarded capital either. However, here it should be emphasized that according to our analysis capital stock estimates show only little sensitivity to alternative assumptions regarding service lives, depreciation patterns and the scale of the one-off reduction of capital. Consequently, in our view the shortcomings of the unreliable data and the lack of information on the heterogeneity of capital may be balanced if the “transitional” characteristics of the data are kept in mind during the analysis.

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Appendix 1.

Using survey data versus historical series of investments

As the HCSO provides data on the end 1999 gross capital stock of the corporate sector, the initial capital approach can also be applied in Hungary. The statistics are based on a wealth-survey (the first overall survey since 1968), which was conducted according to international standards as a part of the HCSO's broader capital stock project. The data is provided in a breakdown by categories (non-residential building and machinery) and by industries (KSH (2002)).

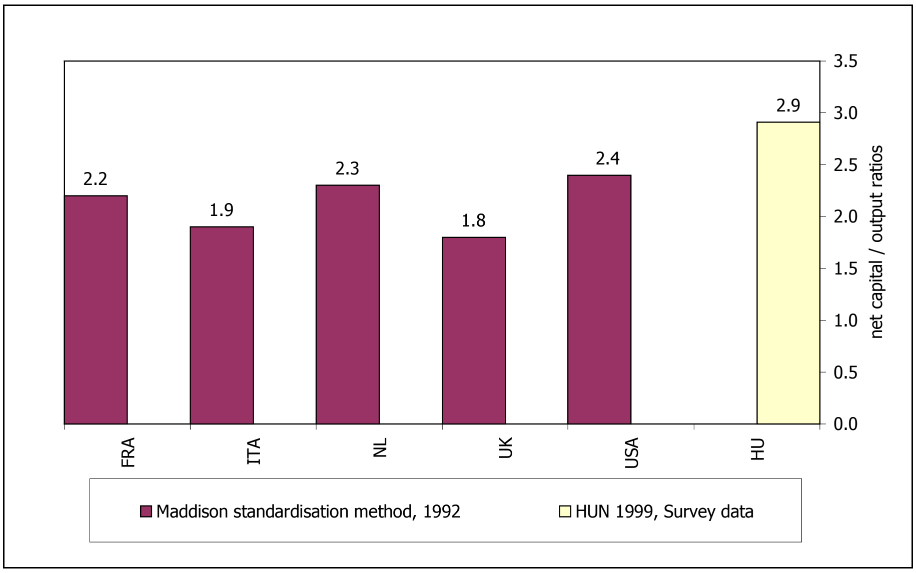
In our analysis we also made calculations with the survey data using the *initial capital approach* and found a serious discrepancy between the survey data and the historical investments series. The level of the survey-based capital stock turned out to be so high that even with extreme service lives of 120 years for buildings and 70 years for machinery the sum of investments was lower than the capital stock. This discrepancy indicates that either the investment series, or the survey data are unreliable. We estimated the capital stock using both approaches and evaluated our results according to their interpretability in an international comparison.

The deviation between the net capital-output ratios of the two different approaches is striking. The capital stock based on the *vintage model approach* (using historical investment series) is approximately one-half of the estimate arrived at the *initial capital approach*. According to the literature, capital stock estimates from wealth surveys have a tendency to exceed those based on historical investment data; the difference, however, in our case seems to be too high by international standards. For example, in the case of Korea, Timmer and van Ark (2000) found that their investments-based estimation was 75 per cent of the official survey-based capital stock value and in the case of Taiwan the difference was even smaller.

The international data does not support the initial capital approach.[7] Comparison with the ratios for developed countries show that the initial capital in 1999 is too high by international standards, i.e. it exceeds the ratio in the UK by 1 point, and the ratio of the US by 0.5. In a word, we presume that the recent HCSO survey tends to overestimate the stock of corporate capital; for this reason we made our calculations using the historical investment series.

[7] To accomplish the international comparison we had to invert the corporate capital to total non-residential capital, i.e. we had to estimate the initial stock of the governmental sector. For this purpose we used the ratio of government investments to private investments as a proxy. Over a five-year-period this ratio is steadily around 20 percent.

Net capital / output ratios in an international comparison



Appendix 2.

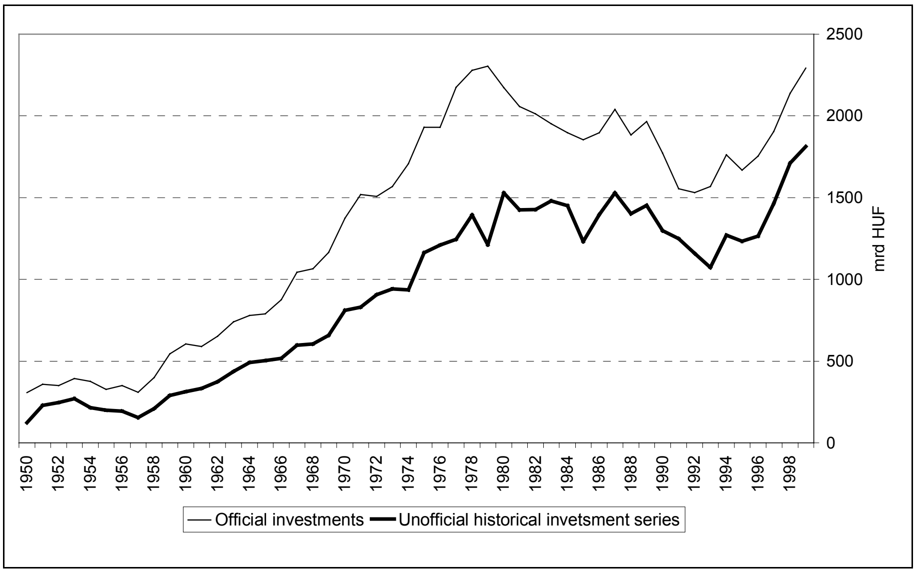
Using official investment data versus historical series of investments

In our analysis we used an unofficial historical investments series of the HSCO. However, there is also an investment series in Hungary that is official, and as such is more easily available and more transparent. The choice between the two data sources is not clear cut, and we give a brief argument supporting our choice in the following. The pros and cons of the data sources may be grouped by the aspects of covering, homogeneity and disaggregation level of the data (see table below).

	Official HCSO investments	*Unofficial historical investments series*
Covering	Includes - the category of other investments (cost of planning and engineering etc.) (+) - residential investments (-)	Does not include - the category of other investments (-) - residential investments (+)
Homogeneity	Several changes in methodology (-)	Considered homogeneous from a methodological point of view (+)
Level of aggregation	No industrial disaggregation (-)	Data at two-digit disaggregation level (+)

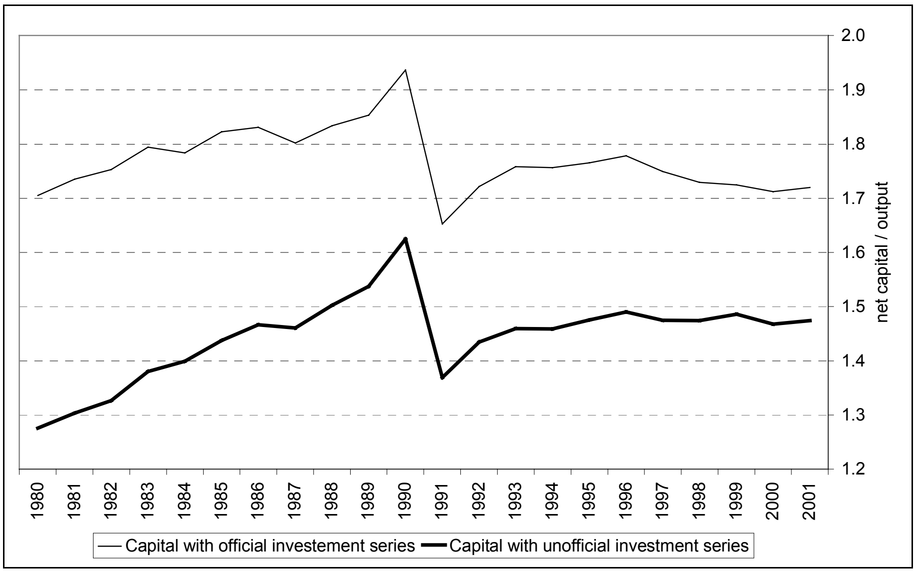
The problem of using the unofficial historical series stems from the fact that it does not include the category of other investments, which amounts to 10 percent of total investments. This component of the series has to be estimated. On the other hand, the elimination of residential investments is a great advantage of the series, as the housing stock should be excluded from the estimation of productive capital. For Hungary, where data on housing is unreliable, the extraction procedure would cause significant difficulties. The two components mentioned above result in a 25 percent difference in covering.

Official and unofficial investments series (at 1998 prices)



The historical time series has two main advantages. First, it is considered methodologically more homogeneous than the official series, as it is built on the statistics of investments put into operation. Second, it is available at a two-digit disaggregation level, and that allows a calculation with different service life assumptions in each industry. However, we also made our calculations on the basis of the official investment series (with the exclusion of residential investments) using the average service lives given by the disaggregated unofficial data. The difference between the two estimations is not striking: the official investment series results in a 0.2 point higher estimation of the net capital-output ratio than the unofficial series.

Net capital / output ratios on the basis of the official and the unofficial investment series



Appendix 3.

The net capital stock for Hungary, 1980-2001

The net capital stock for Hungary, 1980-2001

	in billion HUF, 1999 prices
1980	12 666
1981	13 319
1982	13 945
1983	14 609
1984	15 218
1985	15 580
1986	16 107
1987	16 735
1988	17 216
1989	17 725
1990	18 088
1991	13 396
1992	13 602
1993	13 754
1994	14 148
1995	14 523
1996	14 856
1997	15 382
1998	16 127
1999	16 930
2000	17 588
2001	18 325

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