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Growth Accounting for Visegrad States: Dual Approach

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GROWTH ACCOUNTING FOR VISEGRAD STATES: DUAL APPROACH

Abstract:

The main goal of this paper is to calculate TFP growth for Visegrad states by the use of dual approach to growth accounting and comparison of results. The dual approach is based on factor prices rather than quantities and hence the result should be more reliable. Another advantage is that data about prices are better available. Even if Visegrad states seem to be very similar, results from growth accounting show that economic growth has different sources. TFP and technologies are the main cause of growth in the Czech Republic+ on the other hand, the factor of accumulation plays a very important role in Poland and Slovakia. Hungary is a country where the sources of growth are divided evenly.

Abstrakt:

Cílem příspěvku je spočítat růst SPF (souhrnné produktivity faktorů) pomocí duálního přístupu k růstovému účetnictví pro státy Visegrádu a porovnat výsledky. Duální přístup není založen na množství, ale na cenách výrobních faktorů a tudíž by výsledky měly být spolehlivější. Další výhodou je, že data ohledně cen jsou lépe dostupná. I když se státy Visegrádu zdají být velmi podobné, výsledky růstového účetnictví ukazují, že ekonomický růst pramení z různých zdrojů. SPF a technologie jsou hlavní příčinou růstu v České republice, naopak v Polsku a Slovensku hraje důležitou roli akumulace výrobních faktorů. Maďarsko pak je zemí, ve které jsou zdroje růstu rozděleny rovnoměrně.

Recenzoval:

Ing. Petr Harasimovič, M.A.

1. INTRODUCTION

Growth accounting is a decomposition of the growth rate of output into contributions of individual factors of production. The main point is to find out if it is the factor of accumulation or “something else” that plays the crucial role. This “something else” is usually called Total Factor Productivity (TFP) or Solow residual and measures technology progress.

The first exercise of growth accounting was presented by Solow (1957) and was based on subtracting of weighted growth rates of capital and labor from the growth rate of output. The remaining (residual) part was ascribed to growth of technology. This is primal approach to growth accounting.

The main problem of primal approach is that it relies on measuring inputs such as capital or labor which can be sometimes unreliable. On the other hand, dual approach is based on factor prices rather than quantities, which are usually easier to measure. Another advantage of price-based estimates is that the prices are formed at the markets and agents have an incentive to get the right price. A firm that pays to factor more than its marginal product is wasting money. The other advantage is that data about prices are measured more frequently and are available more easily, especially for cross-country comparison.

This paper takes advantage of the dual approach and calculates TFP growth and its contribution to output growth for Visegrad states. The main goal is to determine sources of economic growth in these countries. The paper is organized as follows: the theoretical derivation of TFP growth rate from factor prices is presented in Section 2. Section 3 briefly describes data and their transformation. Section 4 interprets and discusses results and finally, Section 5 makes summary and concludes with prospects for further research. The Appendix provides more details about the data used for analysis.

2. DUAL APPROACH TO GROWTH ACCOUNTING

The first exposition of equivalence of primal and dual approach was presented by Jorgenson and Griliches (1967). Here, however, we follow a more transparent explanation provided by Hsieh (2002).

He starts with national income accounting identity that output is equal to factor incomes

$$Y = rK + wL \quad (1)$$

where Y is output, K is capital, L is labor and r and w is the rental price of capital and the real wage, respectively.

Differentiation of (1) with the respect to time and dividing by Y gives

$$\frac{\dot{Y}}{Y} = s_K \left(\frac{\dot{r}}{r} + \frac{\dot{K}}{K} \right) + s_L \left(\frac{\dot{w}}{w} + \frac{\dot{L}}{L} \right) \quad (2)$$

where $s_K = rK/Y$ and $s_L = wL/Y$ are the factor-income shares.¹ Rewriting the same in a more convenient way where variables with “hat” denote growth rates gives

$$\hat{Y} = s_K(\hat{r} + \hat{K}) - s_L(\hat{w} + \hat{L}) \quad (3)$$

Placing terms of the growth rates of production factors on left-hand side of the equation, we obtain

$$\hat{Y} - s_K\hat{K} - s_L\hat{L} = s_K\hat{r} + s_L\hat{w} \quad (4)$$

The left-hand side of equation (4) is the primal estimate of Solow residual or Total Factor Productivity growth. Share-weighted growth rates in factor quantities are subtracted from the growth rate of output

$$TFP_{PRIMAL} = \hat{Y} - s_K\hat{K} - s_L\hat{L} \quad (5)$$

The right-hand side of equation (4) is a dual measure of TFP that is obtained as share-weighted growth in factor prices

$$TFP_{DUAL} = s_K\hat{r} + s_L\hat{w} \quad (6)$$

The primal and dual measures of TFP growth rate should be the same with the only condition that output equals factor incomes.² No other assumptions about the form of the production function, bias of technological change or relationship between factor prices and their

¹ In this setting, the sum of factor-shares is equal to unit, $s_K + s_L = 1$.

² Equation (1).

social marginal products need to be made.³ The two measures will differ only if national accounts are inconsistent with the data on factor prices. Hloušek (2007) showed that primal and dual approaches give approximately the same results for the case of the Czech Republic. That means that national accounts provided by statistical office are consistent with factor prices.

The initial goal of this paper was a comparison of primal and dual approach for Visegrad countries but it is quite difficult to obtain consistent data of quantities of factor inputs, especially the data of capital for all countries. Therefore we use only the dual approach which uses factor prices and applies them in the calculation of TFP growth in Visegrad states (namely Czech Republic, Hungary, Poland and Slovakia).

³ If factor prices deviate from social marginal products, the estimated value of TFP would deviate from the “true” value. However, the error from dual approach will be the same as that resulting in the primal approach.

3. DATA

The growth accounting exercise can be extended to allow for different types of capital and labor. However, this paper deals only with aggregate measures of factor prices.

To assure complete consistency of data, one would like to have time series from one source. However, not all data were possible to find in the only database, thus the hypothesis of consistency is slightly violated. The data are obtained from three sources: EUROSTAT, OECD and IMF databases. Frequency of the data is quarterly, sample period is from 1996Q1 to 2006Q4.⁴

Specifically, the real interest rate that measures the rental price of capital is represented by three-month nominal interbank rate deflated by CPI inflation (ex post approach).⁵ The real wage is calculated as a ratio of nominal wage rate and consumer price index. The aggregate output is represented by gross domestic product.

To calculate the TFP growth, we also need factor-income shares. The labor-income share, which corresponds to $s_L = wL/Y$, is calculated as a ratio of total labor cost to gross value added (all in current prices). Subsequently, the capital-income share s_K is computed as a complement to unit: $s_K = 1 - s_L$. These shares are allowed to change over time but the time subscript is omitted for the sake of transparency. The average shares of labor to income, s_L , for all countries are shown in Table 1.

Table 1: Labor shares for period 1996Q1–2006Q4

Country	Labor share in %
Czech Republic	57.8
Hungary	56.7
Poland	61.1
Slovakia	51.5

Note: Low quality of estimate for Hungary, see Appendix for details.

Source: Data OECD, own calculations

It must be mentioned that data of total labor cost were not available for Hungary and some approximation was needed.⁶ Therefore estimations

⁴ More information about raw data can be found in Appendix.

⁵ Actually, the rental price of capital is the real interest rate plus depreciation rate. But assuming constant depreciation rate during the time, the growth rate of the rental price will be the same as the growth rate of the real interest rate.

⁶ See Appendix for more details.

of labor-income share are not completely reliable, which should be kept in mind for further evaluation of results.

The highest share of labor has Poland where agriculture is the main sector of national economy. Agriculture is labor intensive and thus this result corresponds to our view. Slovakia stands on the other side with the lowest labor share from all Visegrad countries. This result is quite surprising and may arise some suspicion about quality of data. Generally, the labor share of Visegrad countries is quite low compared to e.g. United States, where estimates of this number reach value of 66 %. If it is common feature of transforming countries or the data bear the blame, is open question.

4. RESULTS

After transformation of the data, a calculation of the factor prices growth rates and TFP using equation (6) is an easy task. Graphical results (growth rates of the output, factor prices and TFP) for all countries are presented in Figures 2 – 4 in Appendix B, numerical results can be seen in Tables 2 – 5. As quarterly data were used, the growth rates are expressed in both quarterly and annualized expression. The last row shows annualized weighted growth rates of factor prices (using factor-income shares).

Table 2: Growth rates – Czech Republic

	Rental price of capital	Real wage	TFP	Output
Quarterly	-0.04	0.91	0.51	0.69
Annual	-0.16	3.65	2.06	2.76
Annual weighted	-0.07	2.11	2.06	2.76

Source: own calculations

Table 3: Growth rates – Hungary

	Rental price of capital	Real wage	TFP	Output
Quarterly	-0.20	1.07	0.52	1.07
Annual	-0.80	4.28	2.07	4.30
Annual weighted	-0.34	2.42	2.07	4.30

Source: own calculations

Table 4: Growth rates – Poland

	Rental price of capital	Real wage	TFP	Output
Quarterly	-0.03	0.51	0.30	1.05
Annual	-0.14	2.04	1.21	4.20
Annual weighted	-0.05	1.25	1.21	4.20

Source: own calculations

Table 5: Growth rates – Slovakia

	Rental price of capital	Real wage	TFP	Output
Quarterly	-0.04	0.48	0.21	1.08
Annual	-0.15	1.91	0.85	4.31
Annual weighted	-0.07	0.99	0.85	4.31

Source: own calculations

All the countries experienced decrease of rental price of capital which should correspond to increase of capital stock. It is obvious that these countries were undercapitalized in the past and were subject to large investment inflows during the transition. Assuming decreasing marginal product to capital, the rental price had to decrease.

On the other hand, there was excessive employment in these countries. As the economies were being restructurized and people were being dismissed from their jobs, labor productivity and the real

wages, too, increased. This is evident from the growth rates of the real wages for all countries.

The remaining part of output growth that is not ascribed to changes in factor inputs is the total factor productivity (here calculated as weighted sum of growth of factor prices). It is that “something else,” simply something that is not explained; John Vaizey denotes it as “a measure of our ignorance.”⁷ TFP usually represents technological progress, but it is a residual term and it can also cover qualitative increase of the inputs or some other unidentified factors.

Hungary had the highest average growth rate of TFP (2.07 % per year), and was tightly followed by the Czech Republic (2.06 %). TFP growth in Poland and Slovakia was 1.21 % and 0.85 %, respectively.

As shown in Table 6, growth of TFP in respect to growth of output are relatively more important measures. In the case of the Czech Republic, TFP constitutes nearly 75 % of output growth. Growth of output in Hungary can be divided approximately half to half between factor accumulation and TFP. More precisely, TFP can account for 48.2 % of output growth. TFP in Poland and Slovakia is less important. Poland output growth can be explained by TFP from 29 %, in the case of Slovakia only from 21 %.

Table 6: TFP to output

Country	Share of TFP to output (in %)
Czech Republic	74.1
Hungary	48.2
Poland	29.0
Slovakia	21.2

Source: own calculations

These results are quite interesting. Visegrad countries have very similar features and can be treated as a homogenous group. However, economic growth has different sources. If we believe that all the assumptions about shape of production function and remuneration to factor inputs are valid for all countries and TFP growth is mainly represented by technological progress, we can infer following conclusions.

In the case of the Czech Republic, the technological progress plays the most important role. Even if the average growth rate of output was smallest from all Visegrad states, Czech economy can be considered to be quite competitive. The economic growth is not based on extensive type of growth (factor accumulation) but on improvements of technology.

⁷J. Vaizey, *The Residual Factor and Economic Growth*, 1964.

Slovakia stays on the other side with the highest average growth rate of output but technological progress can account only for 21 % of this growth. Does it imply that technology is unimportant in the case of Slovakia? Not necessarily. Barro and Sala-i-Martin (2004) show⁸ that small numbers of TFP (as percentage of growth of GDP) does not mean that technology is not important source of growth. Technology as an ultimate source of growth can explain large portion of economic growth, because it triggers factor accumulation that would never happen without it.

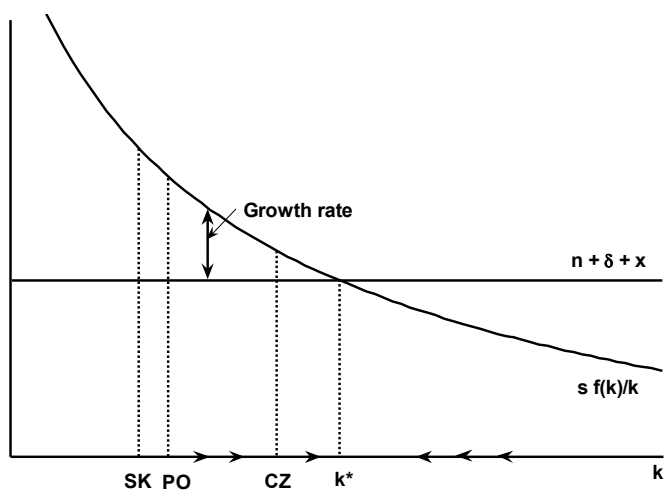
Poland has also very high growth that was mainly driven by factor accumulation. As noted earlier, data about factor-income shares for Hungary are not so reliable and neither are thus conclusions. Without regard to this fact, Hungary had very rapid average growth of output (same as Slovakia), reasons of which seem to be evenly divided between factor accumulation and technology improvement.

From the point of view of economic theory, these differences can be partly explained by the neoclassical growth model, specifically by the Solow (1956) model with exogenous technological progress. Explanation is based on hypothesis of absolute convergence and different initial quantity of capital per person (k). One can see these countries as converging to the steady-state during transition period as it is illustrated in Figure 1.

The Czech Republic has the lowest growth rate of output that is mainly driven by technological progress. This country is nearest to the steady-state (k^*). On the other hand, Poland and Slovakia are farther from the steady-state, with lower level of capital but high rate of its accumulation and thus higher growth rate of output. Hungary is an exception. Very high output growth ranks this country to the latter group yet technology growth is quite important and suggests a position closer to the steady-state. Reasoning can be that Hungary has different steady-state and concept of conditional convergence should be applied.

⁸ Section 10.5.

Figure 1: Convergence



5. CONCLUSION

This paper examined sources of economic growth in Visegrad states using dual approach to growth accounting. TFP growth was calculated as a weighted sum of growth of factor prices. Shares of TFP to output growth indicate what the main determinants of economic growth are. Contrary to some similarities of Visegrad states, different sources stay behind the economic growth during the transition process.

Technological progress is the main cause of growth in the Czech Republic while factor accumulation plays the most important role in Poland and Slovakia. Hungary is a country where the sources of growth are divided evenly.

However, this paper made only first step of the analysis – it showed which main determinants of economic growth are important for every country. Further research should be aimed onto two directions.

One part can be focused on a more detailed analysis of growth accounting. Factors of production (and their remunerations) can be disaggregated with respect to their quality which primarily relates to labor. Next, dual approach can be connected to primal approach in order to find out the exact contribution of individual factors. Due to bad availability of data of capital, its contribution to growth can be calculated as a residual using equation (4) where the only unknown is the growth rate of capital \hat{K} .

Second and more important part of further research should be aimed at identification of fundamental determinants of economic growth such as government policies, household preferences, natural resources, initial level of physical and human capital etc. Growth accounting is only mechanical decomposition and it does not constitute a theory of growth.

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APPENDIX A – DATA DESCRIPTION

The dataset is available on request. The data were obtained from databases of EUROSTAT, OECD and IMF. Frequency of data is quarterly, spanning the period from 1996Q1 to 2006Q4. The series that were not seasonally adjusted from the source were adjusted (when needed) by Kalman filter smoother.

The following raw series from the following databases were used:

EUROSTAT

- Gross domestic product at market prices / unit: Millions of Euro (at 1995 prices and exchange rates) / Seasonally adjusted and adjusted data by working days / Constant prices / All countries
- 3-month interbank rate / per cent p.a. / Cnt: Czech Republic, Poland, Slovakia
- Yield 90-day treasury bills, / per cent p.a. / Cnt: Hungary

IMF

- Consumer Price Index / Index Number / Base year: 2000 / averages / All countries
- Average Monthly Wages / Index Number / Averages / All countries

OECD

- Benchmarked total labor costs – Total / Millions of local currency / Cnt: Czech Republic, Poland, Slovakia
- Benchmarked total labor costs – Industry and Construction / Millions of HUF / Cnt: Hungary
- Total gross total value added at basic prices / Current prices, quarterly levels, S.A. / Millions of local currency / Cnt: Czech Republic, Poland, Slovakia

Total labor costs for all sectors were not available for Hungary. I used labor cost for industry and construction, spanned in the period 2000—2006. These sectors comprise about one third of GDP⁹. The total labor costs were then approximately completed using these fractions and share to gross value added was calculated. The average labor share from this shorter period was used as extrapolation for years 1996—1999.

⁹ Exact numbers were obtained from Statistical reports of Hungarian Central Statistical Office.

APPENDIX B – GROWTH RATES

Figure 2: Growth rates – Czech Republic

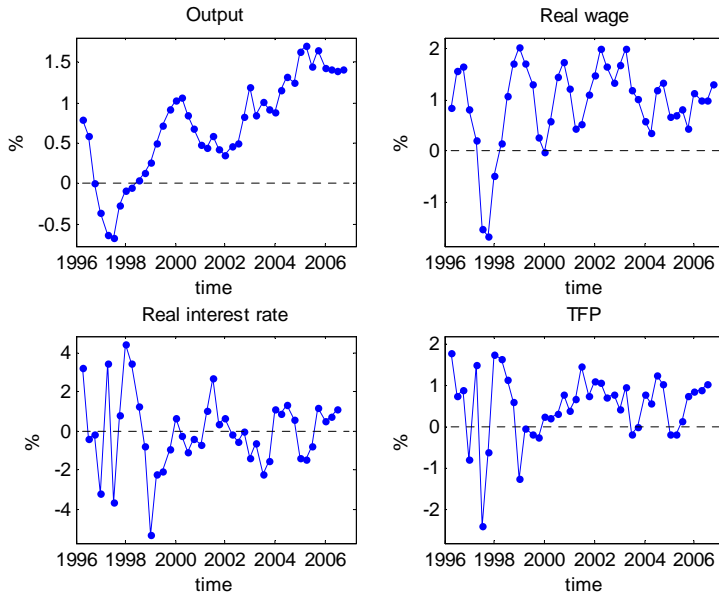


Figure 3: Growth rates – Hungary

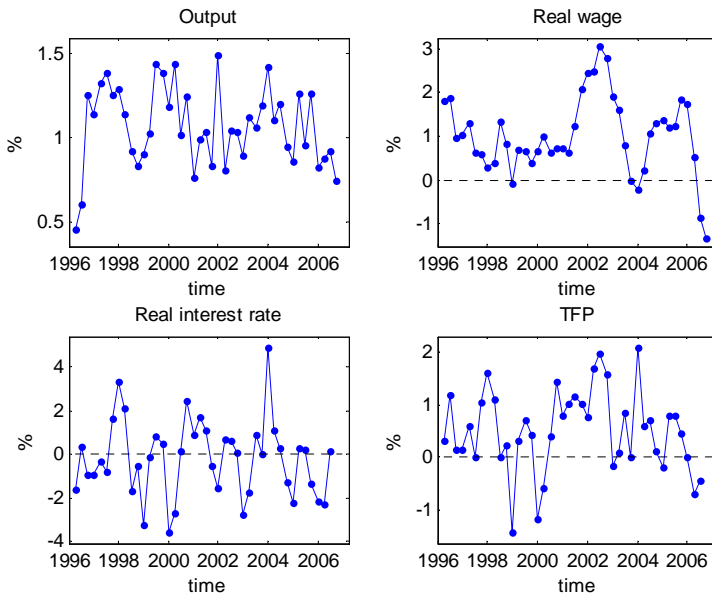


Figure 4: Growth rates – Poland

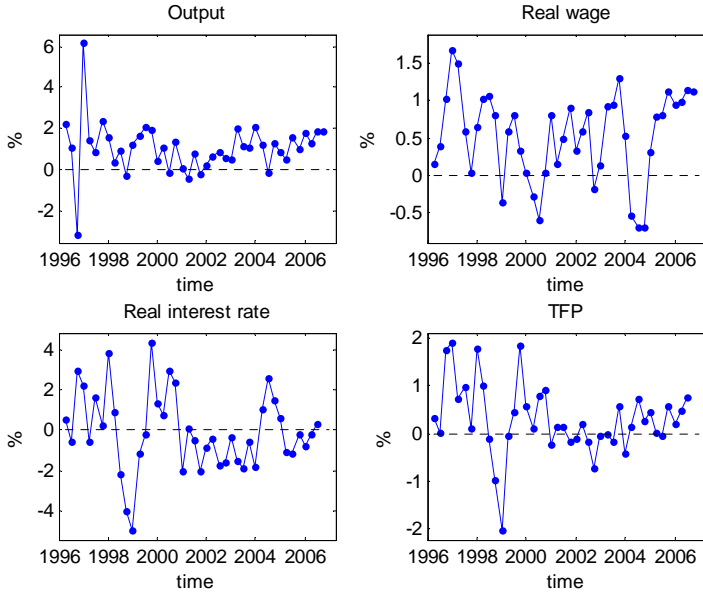
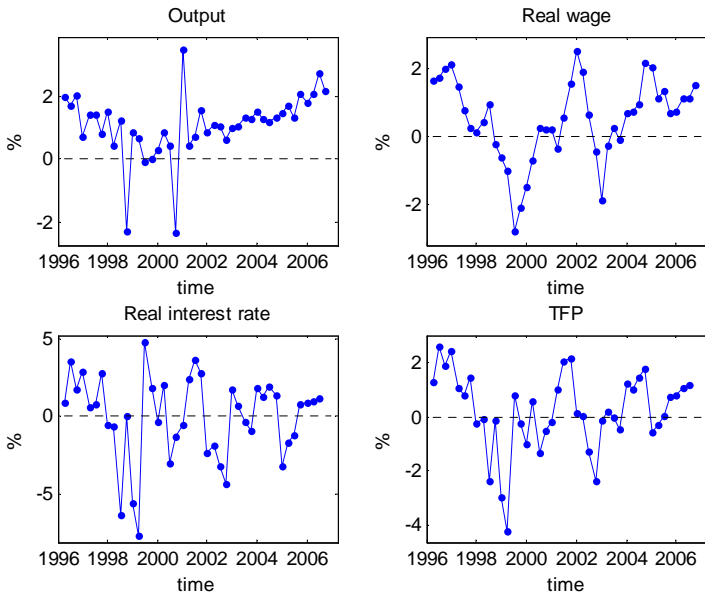


Figure 5: Growth rates – Slovakia



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