YOUNG ECONOMISTS' SEMINAR to
15th Dubrovnik Economic Conference

Organised by

CROATIAN NATIONAL BANK

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Production Factor Contributions to the Economic Growth of OECD Economies at the Industry Level

Hotel "Grand Villa Argentina",
Dubrovnik
June 24, 2009

Draft version

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ABSTRACT

The paper presents research on the industry level growth accounting applied on the case of OECD economies. Even though from the 1990s there was a voluminous literature on aggregate productivity effects, international comparison of industry level growth was neglected. Therefore, due to development of new datasets at the industry level of part of the OECD countries this paper tries to fulfill the gap. Several econometric procedures, based on both stationary and non-stationary panel regression were pursued. Estimation results show robust positive effects of capital accumulation across all sectors and share of high-skilled persons engaged in the sector of manufacturing. However, standard econometric issues still remain open.

Keywords: *Industry, economic growth, OECD, panel regression*

1. Introduction

From the 1990s there is a surge of interest on the effects of production function factors on the economic growth. Especially dominant literature was related to the role of government capital accumulation. However, sources of economic growth differ significantly among industries and that presents a significant restriction for the growth accounting at the aggregate level. That is one of the reasons why aggregate production function is heavily criticized by some authors. In spite of that, there is a voluminous literature on the production function factors contribution to the economic growth. This is true for the industry level but in a lesser extent.

Development of the international databases on the macroeconomic variables enable more detailed research on the sources of growth. Especially important insights can be obtain from studying data on international comparisons. OECD countries are therefore interesting for research as a relatively homogenous group and countries at the end of the production function frontier. In terms of empirical research it is very important to point out that national statistics in these countries is most accurate and updated.

In the second part of the paper, after introduction, brief empirical overview is presented. Third part outlines the methodology of the research. Results of the empirical research are presented in the fourth part. Conclusion offers some guidelines for further research.

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[2] Author is greatful to Peter Pedroni for his assistance related to panel cointegration estimation.

2. Economic growth at the industry level

Majority of the empirical literature on growth accounting is related to the aggregate performance of the economy (see Sturm, 1998, Kamps, 2004). There are at lease three theoretical explanations for being cautious when using the aggregate productivity functions and these are: value added is a function of capital inputs, labor inputs and the level of technology; the production function if the same for all industries and producers face identical factor prices (see Ark, 2001). In spite of that, empirical literature related to aggregate productivity measurement is vast for difference from the industry level growth accounting. There are few examples such as Minasian, 1969, Lynde and Richmond, 1993, Jorgenson and Stiroh, 2000. All of this research is based on datasets at the national level. Therefore, Jorgenson and Stiroh (2000) in examining the growth effects at the industry level of U.S. conclude that the next fruitful step of research will be comparison of patterns of industry growth across countries.

Most of the discussion within the research at the industry level is related to the choice of dependent variable, i.e. the choice between gross industry output or value added. Value added as a output concept has advantages because it avoids double counting of intermediate factors such as raw materials, energy inputs and raw materials. However, Ark (2001) points out that utilization of value-added variable creates a problem for productivity studies because intermediate inputs change their role in the production function. When using the output approach intermediate inputs are within the dependent variable and with the value-added approach they present a part of an explanatory power (i.e. independent exogenous variables). In spite of these shortcomings in this paper, concept of value-added was chosen.

3. Empirical estimation

3.1. Methodology

Value added function of the industries in this paper is given by the following expression:

$$Y_{it} = \alpha + \beta K_{it} + \beta_1 H_{it} + \beta_2 L_{it} + u_{it}$$

where

Y_{it} denote value-added, K_{it} net capital stocks, H_{it} - human capital stock and L_{it} labor by industries.

At the first part of the empirical estimation, unit root tests are performed in order to determine whether data have stationary properties. If that is the case, traditional regression techniques can be performed. Otherwise, if data are nonstationary it is necessary to test for a presence of cointegrating relathionships between variables and conduct panel cointegration estimation. Due to the fact that small sample dataset does not provide clear answer on the nature of data, both avenues are pursued.

At the beginning, fixed and random effect estimation is conducted. In addition to that, Olley-Pakes (1996) methodology was applied in order to control for possible endogeneity problem. Endogeneity issue is related to the possibility that output growth granger causes capital accumulation. It is a common argument in growth empirics that if economic growth leads to more capital accumulation, contribution of capital to growth will be biased upwards.

Olley-Pakes approach demand two step procedure. In this paper investment as a proxy for an unobserved productivity is used as in the original Olley and Pakes paper. They assume that investment can be expressed as a function of capital and productivity. By inverting that function they express productivity as a function of investment and capital. This function enters in the growth equation as a proxy. Due to the fact that functional form of that function is unknown, usual approach is to employ a polynomial expression of investment and capita as a proxy. In this research polynomial of fourth degree was used.

In case that data are nonstationary by employing previously mentioned techniques there is a possibility of obtaining spurious regression coefficients. For that reason, panel cointegration estimation was conducted based on "Fully Modified OLS" technique for heterogeneous cointegrated panels developed by Pedroni (1996). In this general model it is assumed that dependent and independent variable are integrated of order one for each member of the panel. Under the null hypothesis of no cointegration the residuals will also be of order one. Regression and tests are performed both on the assumptions of member specific fixed effects; and member specific fixed effects and deterministic trend.

3.2. Data description

In the recent period there is a new boom of research related to the effects of capital accumulation, role of ICT, human capital and structural shifts in economic growth. One of the reasons for such spike in research lies in availability of data. Several organizations at the same time develop their databases.

This research utilizes data from EU KLEMS database. The study covers 15 OECD countries in period from 1995 to 2005. Even though longer data series for some countries were available the goal of the research was to obtain dataset with as much countries and time periods as is possible considering the variables of the model. The model relies on estimation of contribution of production factors to the value added by sectors of industry. The following data from the EU KLEMS are used

- value added
- net capital stock
- gross fixed capital formation
- total hours worked by persons engaged
- total hours worked by high-skilled persons engaged

Data on value added, net capital stocks and gross fixed capital formation were available in local currency units and in current prices. Therefore, OECD online database was utilized for converting the exchange rates to EUR and constant prices (year 1995 = 100). Time span of the data is 1995 to 2005. Research is based on 15 countries of OECD based on the availability of data. These countries are: Australia, Austria, Czech Republic, Denmark, Finland, Germany, Italia, Japan, Korea, Netherlands, Portugal, Slovenia, Sweden, United Kingdom and United States. Table 1 shows industries (sectors) as level of aggregation used in this research. Sectors A and B are combined in the EU KLEMS database and, therefore, in this research as well.

Table 1: OECD classification of activities

A	Agriculture, hunting and forestry
B	Fishing
C	Mining and quarrying
D	Manufacturing
E	Electricity, gas and water supply
F	Construction
G	Wholesale and retail trade; repair of vehicles and household goods
H	Hotels and restaurants
I	Transport, storage and communication
J	Financial intermediation
K	Real estate, renting and business activities
L	Public administration and defense; social security
M	Education
N	Health and social work
O	Other community, social and personal service activities

Source: OECD (2001, p.28)

All industry-level variables included in the EU KLEMS database have been built from national statistical offices data using harmonized definitions, industrial classifications and aggregation procedures. The EU KLEMS Database uses chain-weighted Tornqvist sectoral price indexes to deflate current value added and obtain value added at constant prices. Such price indexes capture both differences in prices and in the production structure of a country. Aggregation of industries is done by calculating aggregate/group deflators and applying them to the value added measures in current prices (see Timmer, M. et al., 2007).

As a labor factor measure hours worked by persons engaged are used. This is a much better measure of employment, especially in cross-country comparisons. Due to the fact that education in OECD countries is in the high level, in this paper it is assumed that differences in level of human capital among OECD countries can be presented by measure of total hours worked by high-skilled persons engaged. General level of education would not provide enough of variation to obtain significant results.

3.3. Empirical results

3.2.1 Unit root tests

For purposes of determining the possibility of unit root processes within the variables several tests are used. This are Levin, Liu and Chu, 2002 (LLC test), Im, Peseran and Shin, 2003 (IPS test), ADF and PP test based on Fisher results (see Maddala and Wu, 1999). The reason for using several tests is in the fact that all this tests base on different assumptions and do not have same statistical properties, especially in the case of small samples. Tables 2 and 3 present results of mentioned panel unit root tests.

It can be observed that we do not have a clear cut answer on the unit root processes. However, in both tables in majority of cases test indicate presence of a unit root, i.e. fail to reject the null hypothesis of a unit root.

According to the data LLC test in majority of cases reject the null of unit root. However, it is suggested that Levin et al. type of test should be used for panels of moderate size with N between 10 and 250 and T between 25 and 250. Therefore, this unit root test could be inappropriate due to small sample properties. Nevertheless, Monte Carlo simulations performed indicated that the normal distribution provides a good approximation to the empirical distribution of the test statistic, even in relatively small samples (see Baltagi, 2004, p.241). Additional problem is in the limitations of the test because it depends on assumption of independence across cross-sections and it's not applicable if cross-sectional correlation is present. Other tests used here allow for serial correlations to vary across cross-sectional units.

Apart from that, it can be observed that there is a significant difference across industries related to the test results which indicate different dynamics of growth variables. It is possible that variables are not integrated in same order. Value added and net capital stocks in table 1 show both stationary and non-stationary features. The same case is for variables of human capital and labor in table 3. This might be due to low power of tests on the small sample in distinguishing the unit root and near unit root process.

Table 2: Panel unit root tests (individual effects are assumed)

	AB	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**TOTIND**
Y															
LLC test	-4.75*	-3.23*	-3.51*	-2.87*	-3.54*	-1.94*	-2.79*	-0.19	-3.76*	0.68	-3.79*	-2.51*	-1.54*	-2.89*	-1.48*
IPS test	-2.46*	-0.91	-1.83*	-0.94	-1.80*	-0.74	-1.39*	0.80	-0.22	0.44	-2.25*	-2.54*	-0.99	-1.24	-1.26
ADF test	52.08*	39.53	48.28*	36.82	44.17*	37.15	39.28	20.30	31.79	22.48	51.44*	51.95*	36.11	39.91	37.19
PP test	34.94	28.72	12.86	9.69	30.70	22.54	28.78	4.98	12.93	7.52	14.56	22.18	9.81	14.56	10.74
K															
LLC test	-3.07*	-3.19*	-2.00*	-2.73*	-1.10	0.20	-1.32	-1.16	-0.99	0.14	-0.25	-5.70*	2.21	-2.47*	-1.15
IPS test	-2.53*	-2.19*	-0.86	-1.57*	0.42	1.20	-0.51	0.94	1.23	0.33	-0.56	-0.79	1.92	0.13	-0.06
ADF test	53.39*	55.93*	34.05	41.69*	24.95	22.21	32.63	20.32	20.06	24.99	36.58	39.54	15.13	27.79	25.73
PP test	15.33	34.32	16.93	12.27	29.35	9.66	17.62	5.90	7.64	6.46	8.97	10.17	2.86	7.06	7.14
H															
LLC test	-2.19*	-2.85*	0.52	-1.44*	-3.54*	-1.87*	1.56	-3.30*	-3.56*	-4.21*	2.77	-0.92	-1.62*	-0.30	-3.54*
IPS test	1.37	0.18	3.87	0.11	0.47	1.05	2.08	0.52	1.23	0.67	0.81	0.82	0.75	1.82	1.33
ADF test	15.94	26.00	12.91	30.41	32.85	22.04	20.23	28.01	19.89	29.78	19.48	27.63	26.35	16.78	16.21
PP test	34.22	33.47	17.59	37.14	34.50	49.19*	22.88	57.21*	39.41	33.18	18.20	45.84*	25.31	21.76	21.62
L															
LLC test	-3.12*	-0.43	0.97	-1.59*	-3.64*	-2.48*	-2.85*	-2.99*	-3.79*	-5.38*	-1.70*	-2.31*	-0.02	-5.49*	-5.78*
IPS test	1.93	1.88	2.76	1.46	0.13	-0.66	1.17	0.28	-1.25	0.24	0.48	1.39	3.52	-0.15	-1.56*
ADF test	24.12	20.13	17.86	26.49	32.07	43.17*	19.33	25.57	45.69*	27.89	25.93	21.97	6.74	36.72	50.03*
PP test	15.89	24.30	22.72	24.39	20.76	46.99*	30.68	27.84	63.24*	57.27*	30.79	23.35	10.42	59.78*	31.83

* significant at the level of 10%

Table 3: Panel unit root test (individual effects and deterministic trend is assumed)

	AB	C	D	E	F	G	H	I	J	K	L	M	N	O	TOTIND
VA															
LLC test	-5.06*	-4.29*	-5.57*	-6.81*	-4.73*	-4.13*	-5.75*	-6.37*	-4.38	-5.54*	-6.43*	-5.77*	-7.96*	-5.16*	-5.76*
IPS test	0.37	0.49	0.04	-0.31	0.52	0.65	0.27	0.08	0.45	0.28	0.20	0.28	-0.11	0.49	0.12
ADF test	26.82	26.73	28.46	36.10	25.36	21.56	27.35	27.66	26.28	27.52	26.12	24.54	33.25	22.97	26.87
PP test	23.54	9.25	4.39	4.17	7.24	5.89	8.34	12.79	11.60	13.92	16.67	8.47	10.69	9.07	6.25
K															
LLC test	-6.58*	-4.31*	-7.46*	-6.20*	-5.64	-6.53*	-5.89*	-5.98*	-5.32*	-6.47	-6.43	-4.44*	-5.28*	-5.26*	-8.15*
IPS test	-0.23	0.76	-0.04	-0.05	0.57	0.20	0.22	0.37	0.46	-0.10	-0.18	0.08	0.42	0.25	-0.18
ADF test	33.17	24.19	30.52	30.61	20.93	26.18	25.18	23.20	21.87	31.85	32.58	27.52	23.98	25.08	32.87
PP test	11.00	9.84	6.58	11.12	9.77	10.99	13.72	10.94	8.02	10.35	11.02	12.19	18.27	8.06	9.22
H															
LLC test	-2.32*	-3.18*	-3.61*	-3.28	-2.09*	-2.27*	-3.79*	-1.68*	-0.28	0.27	-42.98*	-4.27*	-3.69*	-4.55	-2.22*
IPS test	0.59	0.28	0.41	1.13	1.12	0.69	-0.18	0.73	1.16	1.38	-7.89*	-1.19	-0.91	0.44	0.41
ADF test	26.76	25.93	31.33	21.82	21.61	26.42	38.86	24.23	17.64	19.87	56.91*	47.22*	49.66*	31.54	29.06
PP test	39.22	35.76	28.17	21.79	17.13	36.26	39.93	53.96*	19.95	22.86	20.41	43.36*	50.82*	41.63	27.83
L															
LLC test	-1.24	1.30	-3.15*	-3.83*	-7.09*	-8.02*	-2.31*	-4.25*	-3.88*	-2.94*	-5.88*	-9.70*	-6.44	-2.99*	-5.95*
IPS test	0.59	0.96	0.38	-0.14	-1.26	-1.66*	0.68	-0.69	-0.23	0.48	-1.32*	-1.47*	-0.69	0.41	-0.78
ADF test	29.02	23.24	27.09	32.35	50.70*	55.35*	20.78	45.36*	36.71	28.53	49.41*	54.98*	38.99	28.36	41.35*
PP test	32.04	52.65*	45.66	50.40	36.23	83.80*	19.39	45.26*	57.96*	23.88	45.75*	58.24*	36.55	49.18*	24.12

* significant at the level of 10%

3.2.2. Traditional estimation

As it was mentioned earlier, possibility that data are stationary cannot be ignored and, therefore, traditional approach by using fixed effects and random effects regression is used. Regression results are given in the table 4. It can be observed that both methods give similar results which shows that within-effects dominate between effects. Coefficient of capital accumulation contribution is high and significant in all sectors. Surprisingly, coefficients of human capital and labor exhibit wide range of values. It is not clear why coefficients on these factors obtain negative values in same sectors. However, such dynamics of production function inputs is not an exemption (see Jorgenson and Stiroh, 2000).

A potential problem of endogeneity of capital accumulation can be eliminated by using Olley and Pakes (1996) procedure shortly described previously. On the basis of the results given in the table it can be seen that capital coefficient values are significantly decreased in most of the cases which confirms the endogeneity issue. In addition to that, values on labor significantly change their dynamics and became positive and significant in all sectors. Interestingly, human capital variable shows robust positive and significant results only in the sector of manufacturing which leads to a logical conclusion that share of highly skilled workforce is most important in this sector. Creation of value added in the sector of manufacturing is highly dependent on utilization of high level of technology used by highly educated labor.

Table 4: Regression results based on assumption of stationarity assumption

Dependent variable ln (VA)														
Models	**Within effects**					**Random effects**					**Olley-Pakes procedure**			
Variables /Sectors	**K**	**H**	**L**	**const.**	**R^2**	**K**	**H**	**L**	**const.**	**R^2**	**K**	**H**	**L**	**R^2**
AB	0.71 (8.40)	-0.02 (0.33)	0.24 (0.01)	0.14 (0.16)	0.55	0.69 (11.65)	-0.01 (0.39)	0.24 (3.42)	0.34 (0.59)	0.96	0.64 (45.38)	-0.04 (-1.21)	0.33 (6.19)	0.89 0.94
C	0.89 (13.69)	-0.06 (-1.33)	0.15 (1.85)	-0.66 (-0.97)	0.62	0.87 (17.31)	-0.10 (-2.12)	0.09 (1.43)	-0.18 (-0.38)	0.95	0.86 (49.63)	-0.46 (-4.66)	0.11 (1.77)	0.87 0.95
D	0.89 (18.40)	0.17 (3.02)	0.53 (3.50)	-3.86 (-2.46)	0.77	0.88 (21.13)	0.09 (2.18)	0.17 (2.98)	-0.68 (-2.10)	0.97	0.89 (62.76)	0.19 (3.73)	0.14 (2.09)	0.94 0.97
E	0.96 (19.26)	-0.05 (0.25)	-0.11 (-1.15)	-0.88 (0.25)	0.70	0.98 (23.00)	-0.03 (-0.69)	-0.02 (-0.24)	-1.72 (-3.44)	0.92	0.92 (35.94)	-0.05 (-0.90)	0.19 (2.46)	0.93 0.97
F	0.53 (8.03)	-0.16 (-3.61)	0.35 (2.48)	2.51 (3.22)	0.53	0.55 (8.40)	-0.16 (-3.60)	0.52 (5.79)	1.08 (2.34)	0.94	0.66 (27.67)	-0.24 (-5.98)	0.57 (8.30)	0.92 0.85
G	0.77 (14.32)	-0.05 (-0.93)	-0.02 (-0.11)	2.64 (1.45)	0.76	0.84 (18.82)	-0.10 (-3.12)	0.24 (4.80)	-0.08 (-0.23)	0.98	0.77 (46.47)	-0.37 (-7.53)	0.39 (8.69)	0.95 0.94
H	0.84 (14.75)	-0.07 (-1.72)	-0.49 (-3.71)	4.39 (5.27)	0.66	0.89 (15.52)	-0.17 (-4.42)	-0.05 (-0.66)	1.16 (2.45)	0.95	0.65 (30.62)	-0.21 (-4.79)	0.42 (7.65)	0.93 0.87
I	0.85 (24.63)	-0.03 (-0.88)	0.47 (3.29)	-2.75 (-2.74)	0.85	0.85 (25.21)	-0.02 (-0.59)	0.32 (3.77)	-1.73 (-2.95)	0.92	0.68 (25.21)	-0.15 (-2.05)	0.49 (4.96)	0.88 0.83
J	0.72 (14.73)	0.06 (1.02)	-0.16 (-0.85)	3.46 (2.99)	0.71	0.73 (14.61)	0.08 (1.43)	0.17 (2.27)	1.26 (2.61)	0.95	0.52 (27.51)	-0.03 (-0.39)	0.48 (7.08)	0.93 0.86
K	0.77 (16.71)	0.12 (1.88)	-0.02 (-0.41)	0.74 (1.10)	0.84	0.78 (17.98)	0.09 (1.36)	0.07 (0.17)	0.49 (0.74)	0.87	0.65 (21.75)	-0.15 (-0.76)	0.42 (3.68)	0.87 0.79
L	0.79 (21.15)	-0.19 (-4.31)	-0.15 (-1.19)	2.55 (3.00)	0.76	0.79 (21.16)	-0.19 (-4.91)	-0.01 (-0.05)	1.55 (2.23)	0.88	0.44 (16.54)	-0.08 (-0.85)	0.6987 (7.22)	0.91 0.66
M	0.56 (11.73)	-0.02 (-0.14)	-0.69 (-4.56)	8.73 (9.55)	0.50	0.52 (10.09)	-0.12 (-0.91)	0.07 (0.60)	4.39 (5.88)	0.87	0.32 (13.25)	-0.21 (-2.33)	0.80 (14.58)	0.94 0.59
N	0.67 (9.56)	0.01 (0.09)	-0.31 (-3.08)	5.24 (7.53)	0.61	0.70 (8.85)	-0.13 (-1.14)	-0.06 (-0.54)	3.54 (5.60)	0.91	0.29 (11.13)	-0.15 (-1.75)	0.92 (10.43)	0.92 0.52
O	0.76 (12.85)	-0.14 (-2.23)	-0.10 (-1.33)	2.60 (3.53)	0.72	0.78 (13.28)	-0.178 (-3.14)	0.07 (1.28)	1.42 (2.76)	0.90	0.61 (23.67)	-0.02 (-0.26)	0.54 (7.41)	0.92 0.81
TOTIND	0.89 (29.09)	-0.14 (-4.19)	0.268241 (2.10)	-2.01 (-1.38)	0.92	0.88 (40.34)	-0.12 (-4.17)	0.18 (3.96)	-1.09 (-2.71)	0.98	0.86 (77.70)	0.02 (0.26)	0.19 (2.92)	0.96 0.97

3.2.3. Panel cointegration estimation

It is important to address the issue of relationship between non-stationary variables. Tests for determining the unit root processes conducted earlier indicated probability of non-stationarity of variables. In the presence of unit root processes OLS is biased and might lead to spurious results.

Tables 5 and 6 present results of tests for determining the existence of cointegrating relationships and slope estimates of panel cointegration vectors. Tables report only coefficient of panel estimates for purposes of clarity. Point estimates for different countries in both cases vary significantly.

Table 5 presents estimates based on assumption of individual idiosyncratic disturbances that are specific for each country. Table 6 adds common disturbances that are shared among all members of the panel. Subtracting the time means in this case can be justified by fact that global growth dynamics had similar effects on OECD economies and imposed cross-sectional dependency from such process. However, as Pedroni (2004, p. 618) states “additional cross-sectional dependencies may exist in the form of relatively persistent dynamic feedback effects that run from one country to another and that are not common across countries, in which case common time effects will not account for all of the dependency”.

Regarding the cointegration test statistics it can be seen that in both tables null hypothesis of no cointegration is rejected at the level below 10%. This is especially true for group panel statistics which is similar like in Pedroni (2004).

However, results of cointegration estimation indicate that endogeneity problem is exacerbated. Table 6 reports lower coefficients on capital accumulation. However, it can be seen that one have to be careful when applying the same dynamic patterns across sectors. Positive and significant value on human capital in manufacturing in table 5 becomes negligible in table 6. Cross-sectional differences in share of high-skill labor in total workforce and dynamics of that share can be lost by such transformations. In addition, it is reasonable to expect sort of endogeneity issue in that case too. Growing industries that are more productive due to high level labor are oriented on increasing and attracting additional labor with such features.

Finally, it can be seen that within total industry value added contribution values on human capital are positive and significant both in tables 5 and 6 and in Olley-Pakes regression function. That might be an indicator of positive spillover effects of highly-skilled workforce from particular sectors to the whole economy.

Table 5: FMOLS estimation (individual effects are assumed)

	AB	C	D	E	F	G	H	I	J	K	L	M	N	O	TOTIND
Slope															
K	0.95 (...)**	0.77 (23.27)	0.94 (72.05)	1.18 (92.81)	0.76 (65.74)	0.95 (...)	0.89 (...)	0.98 (...)	0.95 (...)	0.91 (...)	0.87 (...)	0.90 (...)	1.02 (...)	0.95 (...)	0.93 (184.32)
H	-0.33 (-11.5)	-0.24 (-2.56)	0.23 (2.14)	-0.34 (-2.26)	-0.13 (-2.97)	-0.20 (-8.46)	-0.73 (-1.42)	0.15 (2.80)	-0.04 (-7.73)	-0.01 (-1.48)	-0.31 (-1.65)	-0.44 (-5.04)	-0.62 (-7.50)	-0.33 (-11.5)	0.23 (4.61)
L	-0.57 (-6.88)	0.02 (-0.15)	0.63 (5.44)	-0.67 (-14.5)	0.03 (-3.12)	0.21 (-1.44)	-0.10 (-1.42)	-0.44 (-0.14)	-0.09 (-7.73)	-0.03 (-1.48)	0.02 (4.26)	-0.48 (-15.1)	-0.64 (-7.50)	-0.57 (-6.88)	-0.11 (-7.05)
Panel statistics															
Panel v	-1.29	-0.16	0.04	-1.05	0.02	0.31	0.10	-0.27	0.64	-0.44	-0.66	0.44	-0.29	0.15	-1.54
Panel rho	0.99	0.60	1.86	2.88*	2.34*	2.25*	1.65	2.70*	2.33*	1.63	2.05*	2.18*	2.36*	1.68*	3.19*
Panel PP	-6.34*	-5.53*	-3.85	-1.66	-0.86	-2.52*	-5.82*	-0.44	-1.46	-5.20*	-1.19	-4.35*	-2.90*	-4.66*	0.86
Panel ADF	-2.49*	-1.71*	-2.92	-4.24*	-2.99*	-2.99*	-2.42*	-1.22	-2.10*	-2.80*	-0.38	-4.67*	-1.58	-2.48*	-1.60
Group rho	3.02*	3.37*	3.96	3.32*	3.33*	3.78*	3.94*	4.29*	4.35*	3.91*	4.17*	3.62*	4.06*	3.61*	4.21*
Group PP	-11.84*	-4.81*	-6.21	-10.43*	-4.66*	-6.96*	-4.72*	-1.35	-0.86	-2.44*	-2.97*	-4.99*	-3.96*	-6.69*	-3.24*
Group ADF	-4.53*	-2.96*	-4.99	-5.07*	-0.69	-3.01*	-3.95*	-1.30	-1.42	-2.09*	-2.08*	-2.71*	-6.24*	-3.77*	-3.79*

* significant at the level of 10%
** very high t-values

Table 6: FMOLS regression (individual effects and deterministic trend is assumed)

	AB	C	D	E	F	G	H	I	J	K	L	M	N	O	TOTIND
Slope															
K	0.69 (38.58)	0.78 (22.69)	0.87 (30.65)	0.52 (19.42)	0.64 (23.71)	0.77 (36.01)	0.68 (30.54)	0.64 (47.50)	0.47 (16.72)	0.84 (56.99)	0.70 (64.67)	0.59 (38.25)	0.76 (34.31)	0.95 (...)**	0.85 (123.04)
H	-0.07 (-1.65)	0.06 (3.19)	-0.00 (0.60)	0.22 (-0.72)	-0.14 (0.85)	-0.12 (3.06)	0.03 (-3.26)	0.08 (2.36)	0.08 (5.57)	-0.24 (-6.53)	0.17 (13.11)	-0.11 (-2.63)	-0.20 (-1.58)	-0.33 (-11.5)	0.05 (2.50)
L	0.37 (9.19)	-0.42 (-2.37)	0.35 (8.44)	0.20 (-1.19)	0.38 (8.74)	0.24 (0.32)	-0.09 (-0.09)	0.38 (9.62)	0.39 (-2.29)	0.22 (9.29)	0.09 (1.64)	-0.21 (-8.28)	0.33 (8.68)	-0.57 (-6.88)	0.41 (21.23)
Panel statistics															
Panel v	-3.12*	-1.27	1.11*	0.00	1.96*	0.98	0.93	1.84*	-1.04	4.70*	17.54*	6.75	10.83*	1.20	6.28*
Panel rho	2.54*	2.32*	3.57*	3.40*	2.86*	4.00*	3.10*	4.15*	3.50*	2.44*	3.99*	3.35	2.53*	3.40*	3.64*
Panel PP	-11.42*	-8.46*	-5.98*	-10.20*	-4.74*	-1.26	-7.48*	0.51	-1.51	-5.86*	-1.65	-7.04	-3.51*	-3.26*	-1.85*
Panel ADF	-1.60*	-1.56	-2.80*	-4.61*	-1.07	-2.76*	-2.72*	-2.72*	-1.87*	-0.65	-1.28	-5.59	0.82	-0.75	-0.67
Group rho	4.42*	4.12*	5.25*	4.55*	4.05*	4.76*	5.26*	5.79*	5.11*	4.38*	5.10*	4.43	4.23*	4.89*	4.98*
Group PP	-16.83*	-9.98*	-10.22*	-12.03*	-10.13*	-6.41*	-5.54*	-1.85*	-4.13*	-10.11*	-7.91*	-7.50	-8.59*	-11.79*	-5.67*
Group ADF	-3.35*	-2.28*	-6.85*	-2.99*	-0.09*	-2.83*	-2.08*	-5.09*	-2.31*	-0.91	-2.01*	-1.93	-2.96*	-3.87*	-3.13*

* significant at the level of 10%

** very high t-values

4. Conclusion

Results of the empirical estimation conducted in this paper indicate robust positive effects of capital accumulation across all sectors and share of high-skilled persons engaged in the sector of manufacturing. However, lack of power of econometric methods in determining the underlying data generating processes demands caution in interpretation of results. In addition, standard problem of endogeneity in growth accounting is not possible to eliminate with current econometric tools.

Further research will be oriented towards determining interactions between production factors and research on growth patterns on the bases of more detailed, sector specific dynamics. New statistical databases enable such research and present a significant improvement in the progress of empirics of growth accounting.

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