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Measuring Production Factor Contributions to Growth: A Novel Expenditure-based Sectoral PPP Approach

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ABSTRACT

The paper presents research in the field of industry level growth accounting applied on the data of ten OECD economies. Even though from the 1990s there has been a voluminous literature on the relationship of production factors and economic growth at the aggregate level, due to the lack of available data international comparison of industry level growth has been relatively neglected. Paper develops a novel methodology for constructing the sectoral purchasing power parity indices which can be used in numerous studies that deal with comparative based growth empirics. In this case, by using the panel group mean estimation approach, it was shown that the growth dynamics and contribution of production factor across industries significantly differ. Such state suggests clear policy recommendations. There are significant benefits in optimizing the structure of inputs across industries. Results indicate very high rates of return on capital accumulation but also on increasing the level of education in the economy. However, such dynamics is not similar for all of the industries and this provides scope for the implementation of more effective industrial policies.

Key words: production factors, economics growth, purchasing power parity, industry level, OECD

1. Introduction

Growth accounting methodology provided by the neoclassical theory framework inspired numerous contributions in trying to explain the drivers of economic growth. We can isolate several directions of research driven from this starting point. Previous empirical studies of the effects of capital accumulation, labour and education is extremely fertile. The first direction of the research is the time-series and panel-data study of the impact of factors of production functions at the aggregate level, which began intensively in 1990s. Extensive overview of the empirical literature in this field is provided in Sturm (1998) and Kamps (2004).

The second strand of the literature refers to the so-called level accounting that directly applies neoclassical growth accounting framework for determining the basic factors of economic growth on the assumptions of constant scale of returns. This approach is standard and implemented in regular reports of the National Bureaus of Statistics and international organizations such as OECD. However, such research is conducted mainly on the aggregate national level due to the lack of data and numerous methodological issues. Additional development of this research has been based on contributions by Jorgensen, Kuroda and Nishimizu (1987) and Jorgensen and Kuroda (1990). These authors disaggregate growth contribution of production factors in certain sectors. Besides them, many other authors pursue this avenue.

Additional stream of interest has been devoted to the question of sectoral convergence (see Bernard and Jones (1996), Arcelus and Arocena (2000). The notion that aggregate growth

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level of OECD economies is converging inspired authors to research the underlying dynamics of this phenomena. In other words, the issue is whether such convergence is caused by the sectoral convergence dynamics or is the consequence of some other process. Research so far does not provide clear-cut answer to this question.

One of the main reasons for problems in research related to the sectoral growth accounting issues, besides lack of available data, is that inappropriate conversion factors for converting the currencies into a common currency unit. Many authors still use aggregate GDP PPPs which are inappropriate due to significant differences in relative price changes across industries. Some authors tried to derive their own estimates, either from the expenditure approach or from production approach. However, so far, derivation of sectoral PPPs by expenditure approach was considered inaccurate, and productivity approach, despite its theoretical advantages, suffers from lack of practical utilization due to complex weighting and averaging process that limits time-span of sectoral PPPs and aggravates the potential measurement errors.

This paper presents a simple and novel approach in deriving the sectoral PPPs in order to estimate the contributions of production factors to growth. The advantage of this approach is that it provides simple adjustment of aggregate GDP PPPs and takes into the account the movement of relative prices across industries. In addition, this approach does not suffer from the base year problem, which is usual problem common for the previous sectoral PPPs derived by different authors. Sorensen and Schjerning (2008) provide overview of the issues related to the sectoral PPPs derivations. The issue of appropriate conversion factors is important due to the fact that these factors directly determine the results on the issue of convergence (or divergence) of growth. In this paper the estimation of contribution of capital accumulation, labour and human capital is estimated by using the pooled mean group (PMG) estimator which validity stems from the assumption of long-run convergence. In case that inappropriate conversion factors are utilized, especially due to the base year issue, the results of the estimation would be substantially biased.

Using the simple framework presented in this paper, a base for further research in the field of economic and industrial development is broadening. This is valid especially for the empirical research related to level growth accounting, issues of economic convergence and more detailed research related to the industry level. Estimation results in this paper clearly show evidence of different growth dynamics at the industry level, provide proof of importance of capital accumulation and education in the long-run and show that factor contributions are clearly industry-specific. Such results open space for substantive policy recommendations and broaden expand the scope for future research.

2. Data and construction of sectoral PPPs

2.1. Data

In the recent period there was 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 the availability of data. Several organizations at the same time have been developing their databases.

This research utilizes data from EU KLEMS database. The study covers 10 OECD countries in period from 1980 to 2005. These countries are: Australia, Austria, Denmark, Finland, Italia, Japan, Korea, Netherlands, United Kingdom and United States. Even though longer data series for some countries were available, the goal of the research was to obtain a dataset with as much countries and time periods as possible, considering the variables of the model. The model relies on estimation of contribution of production factors to the gross value added by sectors of industry. The following data from the EU KLEMS are used:

- gross output at current basic prices
- gross value added at current basic prices
- taxes minus subsidies on production
- net capital stock
- gross fixed capital formation
- total hours worked by persons engaged
- total hours worked by high-skilled persons engaged
- gross output price indices
- gross value added price indices
- real gross fixed capital formation
- gross fixed capital formation price indices

All data from the database were available in local currency units. Therefore, in order to be able to compare selected variables, appropriate conversion factors had to be utilized. In this particular research, a novel approach for determining the sectoral PPPs on the basis of aggregate GDP PPPs is applied. 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: Level of aggregation

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 defence; social security
M	Education
N	Health and social work
O	Other community, social and personal service activities

Source: EU KLEMS

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 indices to deflate current value added and obtain value added at constant prices. Such price indices 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, et al., 2007).

As a labour 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 at 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.

2.2. Construction of sectoral PPP's

International comparisons of productivity used the exchange rate or aggregate GDP PPPs in order to facilitate comparisons of productivity and levels of economic development among countries. However, such conversions are problematic due to several reasons which will be explained in more detail further in the text. In order to avoid errors in measurement and evaluation of factors of production functions and relative productivity among countries, it is extremely important to use the exchange rate conversion factors at the same level of aggregation as variable that is compared between countries. In fact, when it comes to the sectoral level, productivity comparisons between the two countries, when using the aggregate PPPs, are accurate only if the two countries have the same relative prices. However, this situation is not probable and possible even in bilateral cases and when comparing countries with similar structural characteristics.

Numerous studies have so far used the aggregate PPP for purposes of converting the sectoral output and sectoral production function factors in the same currency unit (common currency). These are, for example, Dollar and Wolff (1988), Bernard and Jones (1996), which is understandable because these are not recent papers and at that point databases, have not adequately provided the ability to create sectoral conversion factors or certain approximations. However, numerous recent works, such as Arcelus and Arocena (2000), Malley et al. (2003), are still using aggregate PPP for the purposes of sectoral comparison. This is not acceptable having in mind that the movement of sectoral prices between countries is rather heterogeneous.

Therefore, many studies attempt to construct sectoral conversion factors. These are Hooper and Larin (1989), Hooper (1996) and Harrigan (1999) that try to use various factor components (component factors) of GDP in order to disaggregate GDP PPPs. However, they were able to use only a few components, which reduce the possible accuracy of this approximation. In addition to the structural elements that define the differences in prices in certain sectors, many authors tried to incorporate important differences that arise due to trade barriers and differences in tax contributions.

Series of studies try to make the sector conversion factors by using data from surveys on consumer prices and consumption such as Pilat (1996). Van Ark and Pilat (1993) used a survey of producers' prices to create unit value ratios, an alternative to sectoral PPP. The problem in using such data is the fact that they use less data and are based only on a particular year. Therefore, although theoretically better, in practice their use is problematic.

Van Biesebroeck (2007) derives expenditure-based sectoral PPPs for several years. He checks the accuracy of several other authors' data on the sectoral PPP on the basis of trends in relative price changes in relation to the U.S. (reference country). He finds that the sectoral PPPs in these studies are not appropriate conversion factor and not only these factors do not pass the test of the base year, but they even don’t match the movement of the sectoral prices. In addition, in many cases he finds using the aggregate GDP PPPs to be better than sectoral PPPs derived on different bases.

An important application of sectoral comparisons of productivity is the debate about convergence. The question is whether productivity in all sectors converges and leads to the observed convergence in the aggregate level or there is another cause for such trends. Sorensen and Schjering (2008) conclude that studies dealing with this issue suffer from problem that sectoral GDP PPPs depend on the choice of base year. They show that in studies in which the base year is close to the beginning of the data span indicate divergence, and vice versa, studies in which the base year is chosen at the end of the period show convergence of the productivity levels.

In order to be able to compare variables related to the production function it is necessary to convert all local currencies into a common currency unit. The exchange rate is not suitable as conversion factors because of its high volatility and dependence on the relationship between tradable and non-tradable sector. Appropriate conversion factor converts the value of domestic product in dollar value of comparable amounts of the same product in the U.S.

In order to construct sectoral PPP conversion factors, one can use either production or consumption prices. Standard GDP PPPs get to use the consumer price derived as the weighted share prices of goods and the consumption based on surveys of consumer and retail prices. Such an approach was first used Jorgenson and Kuroda (1990) to compare productivity of Japan and the United States. Some authors combine the producer and consumer approach (Pilat, 1996, Van Biesebroeck, 2007).

Additional problem in evaluating the validity of some approaches is that the authors mostly use different methods on different data, countries and years. However, exceptions are present such as Sorensen and Schjering (2008) and Van Biesebroeck (2007) that try to compare methods used by other authors.

One of the main debates is how well the sectoral PPP follow sectoral prices. Conversion factors in this study directly utilize price deflators which usually serve as a benchmark of accuracy of different sectoral GDP conversion factors. In addition, sectoral PPPs that are constructed in this paper pass the Sorensen and Schjerning (2008) test as a prerequisite for appropriate conversion factors. Therefore, sectoral PPPs developed in this paper directly challenge the thesis of Sorensen and Schjerning (2008) that the sectoral PPP simply are not good and that sectoral comparisons are not possible. According to Van Biesebroeck (2007), utilization of sectoral PPPs when comparing the productivity between countries are possible only if they guarantee that their approximate relative price changes between countries are better than aggregate measures. In this paper, such a claim is proved and thus the used data and methodology represent a starting point for exploring various directions in the analysis of international productivity. Therefore, Van Biesebroeck (2007) tries to determine which measures aggregate or sectoral PPP better monitor price changes relative to the USA. Although it is theoretically logical that the sectoral PPP always perform better, because of errors due to construction of PPP that is not always the case. This method, which is presented in the paper, reduces possible erroneous derivation of PPPs to the credibility of the deflator. In other words, the answer to the question whether aggregate or sectoral PPP conversion factors are more accurate, is related to the extent of errors that are related to the weighting during their construction. However, this error is reduced because the EU KLEMS database follows standardized and homogenous approach in deriving the data from national sources.

Price deflators use domestic weights in order to aggregate more products. The problem that exists when creating sectoral PPPs is that these are much more susceptible to weighting method because the consumption patterns differ between countries. Accuracy of approximation will depend to the extent that base KLEMS manages the EU harmonization of pricing deflator between individual countries. Rao (2001) warns that the derivation of sector PPPs that are based on changes in relative prices compared to the reference country (based on different weighting in the construction deflator) would be inappropriate.

Study of Sorensen and Schjerning (2008) is important because it argued for the thesis that conversion factors based on consumer prices are inappropriate for international comparisons of the level of output in the manufacturing sector. Their test for the suitability for the method of conversion is whether the conversion factors are independent of the choice of base year. According to them, the results of analysis of previous studies are disappointing: relative measures of productivity depend significantly on the choice of base year and change systematically as the base year changes. Thus, the authors note, "Therefore, rethinking the methods for developing conversion factors for sectoral productivity comparisons is needed." (p. 327.). Furthermore, the claim that a consequence of that is the fact that international comparisons based on such measures potentially lead to false results and conclusions: "This may be the case for productivity ranking, catch-up and convergence analysis, analysis of technological progress, analysis of structural change, and measurement of unit labour costs and thus analysis of competitiveness "(p. 327.).

As it was already mentioned, in this research a simple methodology that incorporates the movement of relative prices is presented. Growth of relative prices in other studies is used as an indicator of accuracy while here it is directly used as a tool for deriving the sectoral conversion factors. Besides that, by using the normalization procedure sectoral GDP do not depend on the phenomenon of the base year.

In this research, gross value added (GVA) price deflator is adjusted for the amount of paid taxes minus subsidies in order to move as close as possible to the industry prices. Differences that occur due to trade barriers were not included and there is a relevant issue of the accuracy of constructing these price differences for purposes of adjustment.

According to the theory, purchasing power parity expressed relative to the USA economy, presents the number of certain currency units necessary to purchase same basket of goods that cost 1$ in USA. Therefore, we can write:

$$PPPGDP_{it} = \frac{P^{GO}{}_{it}}{P^{GO}{}_{USAt}} \qquad (1)$$

where t denotes year and i country. Term GO refers to gross output which is the best proxy for deflating the aggregate GDP PPS since it reflects the prices on consumption of final goods and services.

Previous term denotes aggregate GDP PPP[2]s derived from aggregating and weighting data from the surveys of consumer prices. In order to obtain proxy for sectoral PPPs we can easily expand the previous term into:

$$\frac{PPP^{X}{}_{it}}{PPPGDP_{it}} = \frac{\dfrac{P^{X}{}_{it}}{P^{X}{}_{USAt}}}{\dfrac{P^{GO}{}_{it}}{P^{GO}{}_{USAt}}} \qquad (2)$$

where term in the nominator refers to the sectoral price deflator. In case of deriving sectoral PPPs for value added, value added price deflators are used, and similarly, for deriving the PPPs for capital accumulation, a capital stock investment deflator is used. From here it is straightforward to derive sectoral PPPs.

However, the base year problem still remains since all price deflators are expressed in constant prices. Therefore the shape of function of sectoral PPPs would depend on the particular base year used to derive constant prices. Fortunately, in this sense a mathematical solution overcomes the problem of index numbers. After deriving the sectoral PPPs based on certain year it is necessary to normalize both these conversion factors, as well as GDP PPPs and use the obtained normalization results to derive sectoral PPPs independent from the base year. By normalizing the sequence of PPPs the base year issue becomes irrelevant due to the fact that normalization expresses rates of growth of prices which are the same regardless of the reference year used for deriving the constant prices. Normalization is presented in terms (3) for the aggregate GDP PPPs and in (4) for sectoral PPPs:

$$\frac{GDPPPP_{i1}}{\sum_{t=1}^{n} GDPPPP_{it}} + \frac{GDPPPP_{i2}}{\sum_{t=1}^{n} GDPPPP_{it}} + \cdots + \frac{GDPPPP_{in}}{\sum_{t=1}^{n} GDPPPP_{it}} = 1, \qquad (3)$$

and

$$\frac{PPP^{X}{}_{i1}}{\sum_{t=1}^{n} PPP^{X}{}_{it}} + \frac{PPP^{X}{}_{i2}}{\sum_{t=1}^{n} PPP^{X}{}_{it}} + \cdots + \frac{PPP^{X}{}_{in}}{\sum_{t=1}^{n} PPP^{X}{}_{it}} = 1 \qquad (4)$$

Finally, by using (3) and (4) and introducing in (2) we obtain sectoral PPPs independent on the base year:

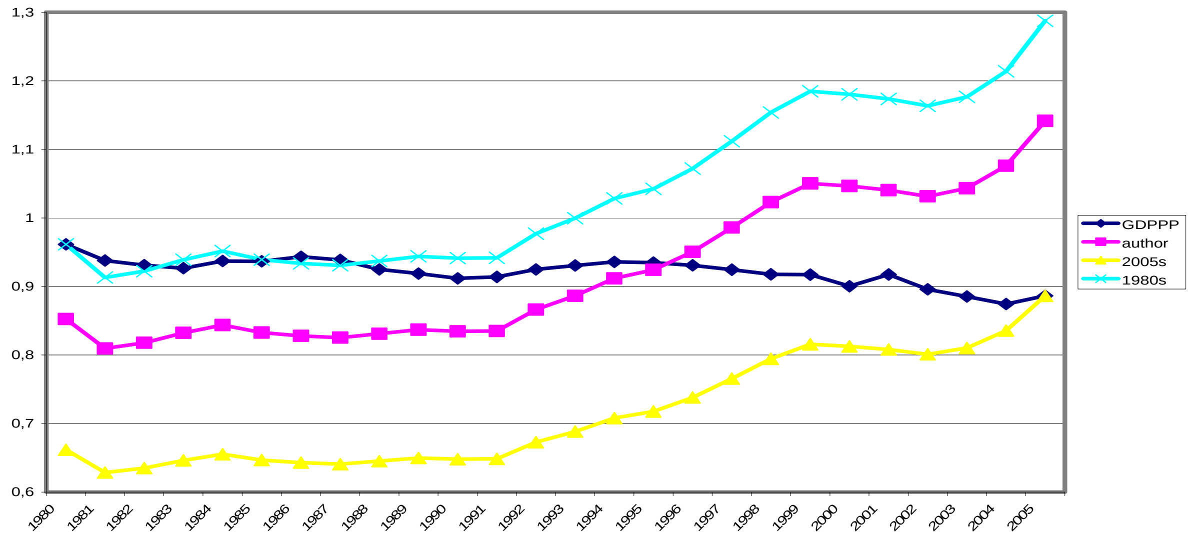
$$PPP^{X}{}_{it} = PPPGDP_{it} * \frac{\dfrac{PPP^{X}{}_{in}}{\sum_{t=1}^{n} PPP^{X}{}_{it}}}{\dfrac{GDPPPP_{in}}{\sum_{t=1}^{n} GDPPPP_{it}}} \qquad (5)$$

where i denotes country and t=1980..2005 (1..n) denotes time period.

[2] It is important to note that even aggregate GDP PPPs present approximation of real PPP values since they are derived by extrapolating the PPPs from the year 2005 where PPPs were derived from the averaging and weighting of prices on consumer goods and services.

Graphically, it is easy to show that such approximation integrates sectoral prices in GDP and therefore provides much better measures for sectoral PPPs than using the aggregate PPPs or sectoral PPPs derived in previous studies (figure 1). This is especially due to the fact that these sectoral PPPs do not suffer from the serious problem of base year dependency. This dependency is especially important in studies of convergence due to the fact that it influences the final results of such research. It is important for the research that includes time dynamics as well, because depending on the choice of base year underestimates or overestimates production function factors. Therefore, this methodology provides a framework for re-estimation of empirical research on different areas related to the growth empirics.

Figure 1: Base year effect on PPPs – manufacturing sector in Austria



Source: OECD, author's calculation

3. Panel unit roots and cointegration testing

3.1. Unit root tests

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. In case that data are nonstationary by employing previously mentioned techniques, there is a possibility of obtaining spurious regression coefficients. Otherwise, if data are nonstationary it is necessary to test for a presence of cointegrating relationships between variables.

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 the fact that all these tests are based on different assumptions and do not have the same statistical properties, especially in the case of small samples. Tables 2 to 5 present results of mentioned panel unit root tests.

Panel unit roots are performed on variables in levels and first differences. One group of tests assumes individual effects, and the other one both individual effects and time trend included in the regression tested. It can be observed from the data in the tables that tests show presence of unit root in almost all cases where variables are in levels. Differencing in all cases removes unit root and we can straightforwardly state that variables are integrated of order 1. However, the fact that variables in some sectors are stationary in levels might cause loss of information when differencing. In addition, the case if variables are not integrated in the same order makes estimation problematic. However, such dynamics might occur due to low power of tests on the small sample in distinguishing the unit root and near unit root process.

3.2. Panel cointegration tests

After determining the order of integration of the variables, i.e. checking weather they are stationary and integrated in same order, it is important to proceed to the cointegration analysis. In order to conduct unbiased estimation it is not enough to perform regression analysis with the variables of same order - they have to be cointegrated. In this paper several tests proposed by Pedroni (1996, 2000, 2001) are conducted.

Pedroni presents seven tests for the null hypothesis of no cointegration using residuals estimated from panel regressions. It is important to denote that the first four tests are derived by using the data "within" dimension and other three (group) tests are focused on "between" dimension of the dataset. The difference here is that within-dimension statistic assumes cointegration with same autocorrelation coefficients of residuals across countries and "between-dimension" statistics assumes country-specific autocorrelation coefficients of residuals. In addition, Pedroni (2000) determines that in case of small samples panel ADF and group ADF test performs better than others.

Pedroni's cointegration tests are performed both in cases with individual effects or individual effects and deterministic trend in the regression equation and presented in table 6. It is interesting to observe that the data in the table do not provide a clear-cut answer to the cointegration. However, it can be noted that in some industries such as mining and quarrying, manufacturing, real estate, renting and business activities and part of the government activities results show higher probability of cointegration. An additional problem is that cointegrating vector in Pedroni test assumes at least one cointegrating relationship and the model has three regressors, which complicate the analysis. Usually, for such reasons, cointegration analysis is restricted to a minimum number of variables.

4. Estimation results

4.1. Methodology

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

$$\ln Y_{it} = \beta \ln K_{it} + \beta_1 \ln L_{it} + \beta_2 H_{it} + u_{it} \qquad (6)$$

where

Y_{it} denote value-added, K_{it} net capital stocks, H_{it} - human capital stock (ratio of highly educated workers in total workforce) and L_{it} labour by industries, and u_{it} denotes the error term and i=1.. N is country-specific and t=1..T time period term.

According to the previously conducted panel unit root and cointegration tests it is reasonable to assume that variables are I(1) and that industries are cointegrated (however, the latter assumption is rather problematic). However, it is reasonable to assume that majority of value-added growth dynamics across industries follows the ARDL (1,1,1,1) process that gives the following equation (compare with Peseran, Shin, Smith, 1999) :

$$\ln Y_{it} = \mu_i + \delta_{10i} \ln K_{it} + \delta_{11i} \ln K_{i,t-1} + \delta_{20i} \ln L_{it} + \delta_{21i} \ln L_{i,t-1} + \delta_{30i} \ln H_{it} + \delta_{31i} \ln H_{i,t-1} + \lambda_i \ln Y_{i,t-1} + u_{it} \tag{7}$$

Reparametarization gives the error correction equation:

$$\Delta \ln Y_{it} = \phi_i \left[\ln Y_{i,t-1} - \theta_{01} - \theta_{1i} \ln K_{it} - \theta_{1i} \ln L_{it} - \theta_{1i} \ln H_{it}\right] - \delta_{11i} \Delta \ln K_{i,t-1} - \delta_{21i} \ln L_{i,t-1} - \delta_{31i} \ln H_{i,t-1} + u_{it} \tag{8}$$

where

$$\theta_{0i} = \frac{\mu_i}{1-\lambda_i},\ \theta_{1i} = \frac{\delta_{10i} + \delta_{11i}}{1-\lambda_i},\ \theta_{2i} = \frac{\delta_{20i} + \delta_{21i}}{1-\lambda_i},\ \theta_{3i} = \frac{\delta_{30i} + \delta_{31i}}{1-\lambda_i},\ \phi_i = -(1-\lambda_i) \tag{9}$$

Additionally, we check the robustness of the results by employing the mean group estimator (MG) where the coefficients estimated for the n=10 equations were averaged:

$$\ln Y_{nt} = \mu_i + \beta_{n1} \ln K_{nt} + \beta_{n2} \ln K_{n,t-1} + \beta_{n3} \ln L_{nt} + \beta_{n4} \ln L_{n,t-1} + \beta_{n5} \ln H_{nt} + \beta_{n6} \ln H_{n,t-1} + \phi_n \ln Y_{n,t-1} + \varepsilon_{nt} \tag{10}$$

It is useful to compare results of PMG and MG, since the PMG is intermediate estimator between the dynamic fixed effects (DFE) and the MG. MG is likely to be more consistent than the PMG estimator since it is less restrictive; however, it is potentially less efficient. MG estimator is derived from averaging the estimated coefficients from separate group regressions. PMG estimator allows the intercepts, short-run coefficients and error variances to differ across groups but imposes the constraint of long-run homogeneity (see Peseran, Shin, Smith, 1999).

4.2. Results

The results of the PMG and MG estimation are given in table 7. It is very difficult to interpret the results, since there are many open econometric issues and different structural dynamics within each industry. However, it is obvious that those industries follow very different dynamics and that more attention should be devoted to particular industries and move from the usual aggregate level approach. Additionally, it has to be stated that the assumption of long-run homogeneity of coefficients does not necessarily hold at the industry level. Even though the observation on the convergence of economic growth in OECD economies is common, this does not necessarily hold for the industry sector. However, due to the fact that these countries share same technological frontier sectoral convergence is also not implausible and numerous research support that tendency.

Estimated country-specific coefficients were not presented; however, as expected they exhibit substantial heterogeneity. For further research, it would be useful to perform PMG estimation with a country-specific ARDL process. However, such approach was not pursued in this paper due to the extensiveness of that approach applied on the sample of many industries.
From the data in table 7, it is possible to derive the following conclusions:

- The clearest results stem from the regression on aggregate industry level. Findings show that long-term growth is related to the capital accumulation and growth of human capital; however, in short term period much more relevant variable is employment and, to a lesser extent, capital investment;
- Coefficients on speed of convergence are significant and relatively high in almost all sectors and robust to the method used with quite different size across sectors; in addition, it can be noted that PMG estimation significantly lowers the coefficients when compared with the MG approach, which is similar to Bassanini and Scarpetta (2002);
- In short term period increase of employment and investments shows positive effects while proxy on human capital does not have significant impact, which is naturally expected;
- In the long-run period in majority of industries it seems that capital accumulation takes over the role of the most important factor which contradicts the standard neoclassical result;
- Human capital in many industries shows positive and significant coefficients; this research broadens the area of research on the role of human capital in economic growth; usually the research is conducted on the aggregate level or, at most, in the sector of manufacturing; results clearly indicate differences in human capital contributions across sectors, which opens space for future research;
- Since the estimated model was log-linear, i.e. estimated coefficient on human capital proxy denotes percentage change or growth rate of value added. That means that long-run rise of growth rates of value added are substantial in some industries and aggregate industry level;
- Since there is a clear evidence of heterogeneity of slopes estimated by using the PMG estimation routines usually utilized would be substantially biased (dynamic fixed effects or generalized method of movements);
- Very high coefficients on capital accumulation on aggregate industry level and in many industries contradict traditional neoclassical assumptions about importance of the capital accumulation for the long-run growth.

5. Conclusion

The main contribution of this paper is in deriving the appropriate conversion factor proxy necessary in order to conduct industry-level growth accounting between countries. This approach provides a simple and much more appropriate approach than using the aggregate GDP PPPs when making growth accounting comparisons between countries. It would be interesting to see how results of the previous studies match when using this methodology and applied in the area of growth level accounting and issue of productivity convergence.

The results of the research have quite clear policy recommendations. In terms of overall economic performance of particular country in the short run, it is important to preserve employment and increase investments. However, in long term only the rise of capital stock accumulation and education level enable growth of productive forces. In that sense, the results confirm that long-term growth is labour displacing.

Growth dynamics in different industries follow different patterns. Therefore, it is necessary to devote more attention to industry level research. A clear policy recommendation is that policy oriented to optimize the production inputs per industry sectors can have significant economic gains and benefits. This argument opens the issues of the quality of industrial policies. Do these policies take into account such considerations? Finally, further research should be directed towards country specific growth accounting, since it is clear from the estimation results that there is a substantial heterogeneity across countries and industries.

References:

1. Bassanini A., Scarpetta S., "Does human capital matter for growth in OECD countries? A pooled mean-group approach", Economics Letters 74 (2002): 399–405
2. Arcelus, F. J. and Arocena P., "Convergence and Productive Efficiency in OECD Countries: A Non-parametric Frontier Approach", International Journal of Production Economics 66 (2), (2000): 105–17.
3. Bernard, A. B. and Jones C. I., "Comparing Apples to Oranges: Productivity Convergence and Measurement Across Industries and Countries", American Economic Review 86 (5), (1996, December): 1216–38.
4. Bernard, A. B. and Jones C. I., "Comparing Apples to Oranges: Productivity Convergence and Measurement Across Industries and Countries: Reply", American Economic Review 91 (4), (2001, September): 1168–69.
5. Carreea, M.A , Klomp, L., Thurik, A.R., "Productivity convergence in OECD manufacturing industries", Economic Letters 66 (2000): 337-345
6. Dollar, D. and Wolff E. N., "Convergence of Industry Labor Productivity among Advanced Economies, 1963-1982", Review of Economics and Statistics 70, (1988): 549–558.
7. Harrigan, J., "Estimation of Cross-country Differences in Industry Production Functions", Journal of International Economics 47, (1999): 267–93.
8. Hooper, P., "Comparing Manufacturing Output Levels Among the Major Industrial Countries. In Industry Productivity: International Comparison and Measurement Issues", OECD Proceedings, Paris: OECD, (1996)
9. Hooper, P. and Larin, K. A., "International Comparisons of Labor Costs in Manufacturing", Review of Income and Wealth 35 (4), (1989, December): 335–355.
10. Im, K., Pesaran, H. and Shin, Y., "Testing for unit roots in heterogeneous panels", Journal of Econometrics, 115, (2003): 53–74
11. Jorgenson, D. W. and Kuroda M., "Productivity and International Competitiveness in Japan and the United States, 1960-1985", In C. R. Hulten (Ed.), Productivity Growth in Japan and the United States, Volume 53 of NBER Studies in Income and Wealth, Chapter 2, Chicago, IL: University of Chicago Press, (1990): 29–57.
12. Jorgenson, D. W., Kuroda M., and Nishimizu M., "Japan-U.S. Industry level Productivity Comparisons, 1960-1979". Journal of the Japanese and International Economies 1 (1), (1987, March): 1–30.
13. Jorgenson, D.W., Stiroh, K.J., "U.S. Economy Growth at the Industry Level," The

American Economic Review, Papers and Proceedings of the One Hundred Twelfth Annual Meeting of the American Economic Association Vol. 90, No. 2, (May, 2000): 161-167
14. Kamps, C., “The Dynamic Macroeconomic Effects of Public Capital, Theory and Evidence for OECD countries”, Springer, New York, (2004)
15. Levin, A., Lin, C. and Chu, C., “Unit root tests in panel data: Asymptotic and finite-sample properties”, Journal of Econometrics, 108, (2002): 1–24
16. Maddala, G.S. and Wu, S., “A Comparative Study for Unit Root Tests with Panel Data and A New Simple Test”, Oxford Bulettin of Economics and Statistics, 61: 631-652
17. Malley, J., Muscatelli A., and Woitek U., Some New International Comparisons of Productivity Performance at the Sectoral Level, Journal of the Royal Statistical Society: Series A (Statistics in Society) 166 (1), (2003): 85–104.
18. Minasian, J.R.: “Research and Development, Production Functions and Rates of Return”, Papers and Proceedings of the Eighty First Annual Meeting of the American Economic Association (May, 1969), The American Economic Review, Vol. 59, No. 2, (1969): 80-85
19. OECD, “Purchasing Power Parities and Real Expenditures - 2005 Benchmark year”, Paris: OECD. (2008)
20. Pedroni, P., Fully Modified OLS for Heterogeneous Cointegrated Panels and the Case of Purchasing Power Parity," Indiana University Working Papers in Economics, No. 96-020. , (1996)
21. Pedroni, P., “Critical values for cointegration tests in heterogeneous panels with multiple regressors," *Oxford Bulletin of Economics and Statistics*, 61, (2000): 653-670.
22. Pedroni, P., “Fully Modified OLS for Heterogeneous Cointegrated Panels”, Advances in Econometrics, Vol. 15, (2000): 93-130
23. Pedroni, P., “Purchasing Power Parity Tests in Cointegrated Panels”, Review of Economics and Statistics, 83, (2001): 727-731.
24. Pedroni, P., “Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis”, Economic Theory, 20, (2004): 597-625
25. Pesaran, M.H., Shin, Y., Smith, R., “Pooled mean group estimation of dynamic heterogeneous panels”, Journal of the American Statistical Association 94, (1999): 621–634.
26. Pesaran, M.H., Smith, R., “Estimating long-run relationships from dynamic heterogeneous panels”, Journal of Econometrics 68, (1995): 79–113.
27. Pilat, D., “Labour Productivity Levels in OECD Countries: Estimates for Manufacturing and Selected Service Sectors”, Economics Department Working Papers 169, OECD, Paris. (1996).
28. Rao, P. (2001). Integration of CPI and PPP: Methodological Issues, Feasibility and Recommendations. Joint World Bank–OECD Seminar on PPPs, 30 January–2 February, Washington, D.C.
29. Sørensen, A., Schjerning, B., “Productivity Measuring in Manufacturing and the Expenditure Approach”, Review of International Economics, 16(2), (2008): 327–340
30. Sørensen, A., “Comparing Apples to Oranges: Productivity Convergence and Measurement Across Industries and Countries: Comment”, American Economic Review 91 (2001):1160–7.
31. Sturm, J.E., “Public Capital Expenditures in OECD Countries: The Causes and Impact of the Decline in Public Capital Spending”, Edward Elgar, Cheltenham, (1998)
32. Timmer, M. et al., “EU KLEMS growth and productivity accounts”, version 1.0,

PART 1 Methodology, (2007)
33. van Ark, B. and D. Pilat, "Productivity Levels in Germany, Japan, and the United States: Differences and Causes", Brookings Papers on Economic Activity: Microeconomics 2, (1993): 1–69
34. van Ark, B. and M. Timmer, "PPPs and International Productivity Comparisons: Bottlenecks and New Directions", Working Paper for Joint World Bank-OECD Seminar on Purchasing Power Parities, (2001)
35. Van Biesebroeck, J., "Disaggregate Productivity Comparisons: Sectoral Convergence in OECD Countries", University of Toronto, Department of Economics, Working Paper 290 (2007, June)

APPENDIX

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

	AB	C	D	E	F	G	H	I	J	K	L	M	N	O	TOTIND
Value added															
LLC test	-0.79	-2.40*	-2.71*	-4.99*	0.51	-1.88*	-0.47	0.45	-5.01*	-0.31	-2.47*	-2.34*	-3.34*	-0.72	-0.95
IPS test	-0.64	-1.89	-1.11	-3.68*	1.22	0.14	0.81	2.79	-2.08*	2.32	-1.79*	-0.80	0.11	0.01	2.23
ADF test	27.03	28.15*	40.43*	53.85*	18.98	25.67	19.75	8.22	40.38*	11.31	42.95*	32.09*	25.79	25.63	18.59
PP test	51.36*	41.28*	27.96	63.68*	9.81	37.38*	21.65	4.70	35.21*	38.50*	36.83*	21.50	40.98*	25.57	31.26*
Total employment															
LLC test	-1.08	-0.64	0.56	2.79	-0.74	-0.90	-2.09	1.59*	-3.28*	-3.73*	-1.55**	-0.28	-0.55	-2.37*	-1.07
IPS test	1.87	2.05	1.33	5.31	-0.049	0.02	0.84	-0.01	-1.07	0.29	0.27	2.43	3.04	1.13	0.87
ADF test	14.74	15.24	22.52	3.42	22.43	24.06	14.22	17.14	32.67	18.13	18.46	9.27	6.66	18.32	16.09
PP test	32.31*	24.62	13.57	2.44	12.22	21.76	13.10	15.19	24.55	26.19	18.11	16.15	6.92	21.56	6.04
Capital															
LLC test	-4.22*	-2.38*	-0.46	1.52	0.38	2.62	0.22	-0.57	2.86	0.54	2.19	2.80	2.58	-1.49**	0.42
IPS test	-2.92*	1.29	0.72	1.47	2.16	3.25	1.53	1.64	1.96	0.54	2.15	3.08	3.75	1.23	1.00
ADF test	48.70*	28.87	15.37	14.96	12.74	20.65	15.49	12.97	26.60	27.77	20.09	11.07	17.00	24.64	19.22
PP test	92.56*	25.61	32.38	44.02*	31.07	45.24*	46.04	34.05	30.17	51.29*	43.31	23.19	23.56	52.19*	47.28*
Human capital															
LLC test	0.56	-1.72*	3.13	1.17	-0.90	1.03	0.19	0.22	-1.85*	-0.26	3.39	0.48	0.18	1.96	3.00
IPS test	2.78	1.17	7.57	2.94	1.10	4.00	2.67	4.13	3.76	3.88	5.35	3.03	3.29	4.07	6.62
ADF test	8.36	14.84	2.18	8.28	11.32	7.25	12.61	10.62	20.23	8.00	4.73	10.54	7.84	7.03	4.64
PP test	6.27	17.73	1.49	13.85	13.70	7.10	9.52	20.75	22.93	11.89	4.31	7.96	7.32	5.28	4.63

* significant at the level of 5%

**significant at the level of 10%

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

	AB	C	D	E	F	G	H	I	J	K	L	M	N	O	TOTIND
Value added															
LLC test	0.04	4.13	-5.79*	-3.61*	-2.64*	-1.56**	-0.24	-0.90	-0.93	-1.65*	-3.87*	-4.07*	-0.55	-1.56**	-1.82*
IPS test	-0.47	3.47	-4.39*	-2.73*	-1.47**	-0.90	0.11	-0.92	-1.02	-1.93*	-3.58*	-3.69*	0.67	-1.99*	-0.87
ADF test	20.36	8.56	62.99*	44.15*	28.88**	31.23**	18.02	25.03	23.23	34.66*	52.18*	51.18*	21.88	34.59*	24.88
PP test	44.47	14.72	25.86	28.27	31.18**	98.12*	14.79	16.68	30.29*	34.91*	21.83	22.14	17.43	35.57*	19.99
Total employment															
LLC test	-0.03	2.25	-1.01	1.21	-0.97	-0.55	-2.09*	0.29	-2.37*	-0.42	-0.19	-0.69	1.03	0.56	-0.77
IPS test	0.18	2.98	-2.17*	3.14	-2.06*	-0.65	0.85	-0.45	-0.71	0.38	0.86	0.59	1.66	1.03	-1.56**
ADF test	18.68	7.42	35.44*	5.59	41.95*	22.55	14.22	21.32	25.59	17.71	14.31	13.03	9.97	14.68	29.98**
PP test	15.09	12.49	14.26	6.69	20.06	16.96	13.10	15.36	26.19	9.17	12.11	21.11	9.69	12.00	18.77
Capital															
LLC test	-2.27	-0.78	-0.58	-1.17	-0.35	-0.24	-1.19	-1.73**	0.60	-0.81	-0.81	-0.82	0.32	-1.85*	-1.15
IPS test	-0.16	3.51	0.96	0.01	2.54	2.23	0.54	-0.54	0.49	2.18	2.35	2.13	2.07	0.38	1.52
ADF test	17.65	6.34	19.98	21.06	14.54	14.71	19.43	32.27*	26.25	12.54	17.47	14.62	24.65	18.29	13.15
PP test	21.55	4.69	27.64	41.94*	18.33	15.21	28.39	62.04*	30.84**	18.05	12.44	18.07	23.17	15.9069	24.0941
Human capital															
LLC test	-0.38	-0.15	1.27	3.72	0.64	0.24	-0.89	-1.13	1.76	2.24	9.46	-1.73*	2.15	1.64	0.62
IPS test	0.19	-0.79	2.01	1.19	0.56	0.47	-0.75	0.95	3.02	2.46	3.41	-0.51	2.55	1.17	1.93
ADF test	18.46	25.01	13.35	19.49	13.56	20.91	27.84	17.45	10.37	12.89	14.08	27.91	7.67	19.65	12.96
PP test	19.39	33.92*	10.32	32.83*	20.99	21.56	20.88	16.03	15.21	15.34	20.31	33.56	11.15	39.71*	13.77

* significant at the level of 5%

**significant at the level of 10%

Table 4: Panel unit root tests – first differences (individual effects are assumed)

	AB	C	D	E	F	G	H	I	J	K	L	M	N	O	TOTIND
Value added															
LLC test	1.71	-3.91	-10.01*	-5.41*	-5.25*	-3.70*	-4.70*	-3.15*	-4.76*	-6.82*	-9.25*	-4.37*	-2.55*	-2.10*	-5.19*
IPS test	-5.17*	-5.15*	-9.95*	-5.43*	-5.80*	-4.78*	-6.29*	-4.58*	-6.52*	-9.70*	-8.60*	-7.81*	-4.10*	-4.81*	-5.02*
ADF test	62.46*	64.90*	125.54*	65.65*	71.59*	59.63*	78.10*	56.55*	81.23*	121.64*	107.57*	98.32*	55.56*	59.24*	64.17*
PP test	192.01*	139.98*	157.88*	111.35*	106.85*	91.16*	116.37*	74.84*	141.43*	164.22*	98.88*	110.31*	83.53*	115.90*	89.99*
Total employment															
LLC test	-5.29*	-3.33*	-4.71*	-2.78*	-4.97*	-5.71*	0.22*	-5.39*	-2.47*	-4.28*	-3.96*	-5.63*	-5.13*	-4.47*	-3.49*
IPS test	-6.37*	-6.20*	-5.26*	-4.29*	-5.67*	-5.80*	0.58*	-6.49*	-3.09*	-5.03*	-6.13*	-6.91*	-5.59*	-5.45*	-4.24*
ADF test	78.91*	80.29*	64.28*	55.89*	71.35*	71.12*	14.48*	81.21*	39.47*	61.66*	77.41*	84.89*	68.74*	68.19*	54.10*
PP test	145.04*	142.62*	71.25*	141.12*	66.91*	76.54*	12.33*	102.42*	81.78*	79.45*	124.20*	141.12*	123.78*	134.58*	52.37*
Capital															
LLC test	-5.37*	-4.17*	-4.53*	-3.21*	-2.93*	-3.90*	-4.23*	-3.33*	-5.00*	-2.87*	-1.56**	-3.53*	-3.37*	-2.25*	-3.95*
IPS test	-5.50*	-5.14*	-4.34*	-5.18*	-3.32*	-3.31*	-3.81*	-4.750*	-6.010*	-2.88*	-3.16*	-3.12*	-3.89*	-3.72*	-3.96*
ADF test	67.33*	64.89*	57.70*	63.91*	46.89*	46.64*	50.18*	59.60*	80.93*	38.99*	44.49*	44.30*	57.65*	49.91*	53.60*
PP test	100.03*	112.66*	77.28*	98.70*	86.51*	56.23*	66.74*	99.82*	94.71*	67.70*	82.48*	62.65*	80.93*	77.28*	67.44*
Human capital															
LLC test	-7.13	-7.25*	-4.79*	-2.28*	-4.56*	-4.60*	-4.96*	-2.73*	-2.82*	-1.29**	12.56	-3.38*	-3.83*	-4.66*	-3.29*
IPS test	-6.96	-8.62*	-5.52*	-6.78*	-6.42*	-6.77*	-8.73*	-6.04*	-4.60*	-4.53*	-1.53**	-6.08*	-4.73*	-7.10*	-4.21*
ADF test	86.67	108.34*	69.68*	96.98*	78.84*	88.17*	111.97*	76.78*	61.48*	61.95*	87.43*	77.44*	60.76*	91.60*	56.40*
PP test	135.47	158.34*	120.12*	146.10*	178.25*	129.08*	141.51*	146.81	132.54*	133.30*	152.45*	143.17*	131.38*	184.23*	100.88*

* significant at the level of 5%

**significant at the level of 10%

Table 5: Panel unit root test – first differences (individual effects and deterministic trend is assumed)

	AB	C	D	E	F	G	H	I	J	K	L	M	N	O	TOTIND
Value added															
LLC test	5.06	-4.55*	-8.09*	-4.55*	-5.17*	-2.48*	-3.51*	-1.34**	-4.54*	-5.73*	-8.49*	-2.37*	-2.14*	-0.69	-3.76*
IPS test	-3.82*	-5.04*	-8.24*	-4.45*	-6.05*	-3.40*	-5.17*	-2.20*	-5.93*	-8.19*	-7.20*	-6.03*	-3.70*	-2.69*	-3.53*
ADF test	46.62*	60.44*	97.22*	54.06*	72.06*	45.00*	63.20*	34.49*	70.34*	95.65*	84.87*	73.16*	47.83*	38.04*	46.15*
PP test	169.82*	135.42*	205.19*	119.61*	113.17*	77.33*	165.67*	53.45*	394.84*	188.52*	89.09*	87.28*	83.65*	87.29*	71.72*
Total employment															
LLC test	-4.11*	-4.83*	-4.23*	-2.20*	-3.50*	-5.11*	-2.12*	-4.24*	-1.31**	-0.42*	-2.67*	-5.22*	-3.84*	-3.94*	-3.49*
IPS test	-4.60*	-7.35*	-4.44*	-3.82*	-4.10*	-4.67*	-4.00*	-5.40*	-2.68*	0.37*	-4.85*	-6.31*	-3.92*	-4.39*	-4.24*
ADF test	58.38*	104.64*	54.93*	50.95*	52.91*	57.36*	49.45*	68.80*	39.36*	17.70*	61.58*	75.94*	49.05*	55.48*	54.10*
PP test	166.64*	398.35*	51.73*	152.88*	49.24*	60.55*	90.17*	114.30*	322.04*	9.16*	148.81*	362.21*	97.49*	119.44*	52.37*
Capital															
LLC test	-5.02*	-10.50*	-5.04*	-1.93*	-1.38**	-5.16*	-3.63*	-2.54*	-5.34*	-2.37*	1.45*	-3.35*	-3.86*	-0.60	-4.64*
IPS test	-5.24*	-10.91*	-4.27*	-4.48*	-2.61*	-4.40*	-2.32*	-4.71*	-5.19*	-2.84*	-3.69*	-3.48*	-4.34*	-3.08*	-4.12*
ADF test	64.003*	129.52*	51.77*	55.73*	40.63*	55.57*	36.16*	58.68*	63.91*	38.66*	50.36*	44.89*	54.00*	47.91*	52.94*
PP test	346.57*	194.01*	77.00*	86.82*	105.11*	79.53*	55.92*	97.78*	576.75*	67.88*	102.00*	68.85*	93.33*	234.92*	61.22*
Human capital															
LLC test	-1.99*	-6.12*	-5.31*	-2.62*	-2.99*	-3.57*	-3.66*	-1.76*	-3.29*	-1.60**	16.17	-2.80*	-3.37*	-3.66*	-3.44*
IPS test	-5.45*	-7.54*	-5.99*	-5.62*	-4.40*	-5.53*	-8.17*	-5.80*	-4.60*	-3.87*	1.78	-4.10*	-3.56*	-5.77*	-3.79*
ADF test	66.90*	89.80*	73.54*	76.18*	53.99*	70.48*	100.28*	72.35*	57.32*	50.55*	73.78*	56.86*	48.85*	74.51*	48.58*
PP test	130.99*	503.03*	132.78*	388.15*	380.53*	419.88*	549.16*	360.16*	394.71*	358.23*	457.05*	390.35*	111.35*	359.30*	92.86*

* significant at the level of 5%
** significant at the level of 10%

Table 6: Panel cointegration test

	AB	C	D	E	F	G	H	I	J	K	L	M	N	O	TOTIND
Panel statistics – individual effects															
Panel v	0.44	0.83	1.37	0.29	-0.85	0.16	0.88	0.93	1.33	1.69**	-0.55	0.43	-1.21	0.68	0.11
Panel ρ	-0.17	0.26	-0.30	0.91	2.08*	1.12	0.77	0.92	-0.04	-1.37	1.32	0.65	2.56*	0.81	1.46
Panel PP	-2.59*	-2.73*	-2.55*	-1.70*	1.49	-0.12	-0.72	-0.05	-2.40*	-5.22*	-1.31	-2.21*	1.52	-1.78**	-0.17
Panel ADF	0.87	-3.93*	-2.57*	-1.22	0.00	-0.00	-1.01	0.39	-0.78	-3.80*	-2.93*	-2.12*	1.78**	-0.28	-0.52
Group ρ	0.54	0.37	0.94	2.06*	2.46*	2.18*	1.81**	2.31*	0.88	-0.51	1.79**	0.95	1.57	2.28*	2.20*
Group PP	-3.37*	-3.03*	-2.21*	-0.83	0.99	-0.86	-0.70	0.68	-2.25*	-5.57*	-1.65	-3.10*	-0.47	0.53	-0.49
Group ADF	0.80	-2.35*	-3.04*	-0.31	-1.27	-0.60	-1.31	1.06	-0.928	-3.98*	-4.69*	-3.25*	0.22	0.20	-1.02
Panel statistics – individual effects and deterministic trend															
Panel v	-0.12	1.24	0.66	0.35	1.09	1.85**	-0.92	1.36	0.73	0.40	0.81	2.12*	-2.67*	0.73	0.57
Panel ρ	-0.25	0.97	1.05	1.95**	2.26*	1.07	2.12*	2.44*	0.48	0.30	2.42*	0.20	4.19*	1.80*	2.91*
Panel PP	-4.95*	-2.20*	-1.70*	-0.76	0.12	-1.49	0.52	1.48	-2.68*	-4.23*	-0.02	-3.53*	3.37*	-0.38	2.11*
Panel ADF	-0.76	-2.60*	-2.03*	-0.97	-3.97*	-1.63	0.13	1.02	-0.71	-3.01*	-3.61*	-3.41*	3.15*	1.25	1.28
Group ρ	0.90	1.59	2.19*	2.45*	3.17*	2.20*	2.72*	3.47*	1.63	1.22	3.22*	1.75*	2.40*	2.82*	3.43*
Group PP	-6.01*	-2.14*	-1.61	-1.73*	0.155	-1.07	0.07	1.82**	-2.12*	-5.96*	-0.07	-2.23*	-0.48	0.02	1.69**
Group ADF	-0.53	-1.82*	-2.58*	-1.155	-3.869*	-1.53	-0.90	0.33	-1.19	-4.31*	-5.80*	-3.68*	-0.73	-0.571	0.60

* significant at the level of 5%

** significant at the level of 10%

Table 7: Pooled mean group estimates and pooled mean estimates for OECD countries

	AB	C	D	E	F	G	H	I****	J	K	L	M	N	O	TOTIND
Pooled mean group estimator															
Long run coefficients															
K	0.41*	0.48*	0.42*	1.01*	0.36*	9.03	0.65*		-0.23*	0.49*	0.16*	0.05	-5.03	0.25*	0.80*
L	-0.29	-0.20	0.05	0.62*	-1.54*	12.72	-0.05		1.01*	0.70*	1.76*	-1.33*	5.11	0.70*	-0.05
H	-0.00	-0.03*	0.06*	0.06*	0.16*	0.05	0.02*		0.02*	-0.00	0.01*	0.02*	-0.49	-0.01*	0.04*
EC	-0.25*	-0.37*	-0.18*	-0.24*	-0.05*	0.00	-0.30*		-0.21*	-0.37*	-0.21*	-0.18*	-0.01	-0.18*	-0.06*
Short run coefficients															
K	0.55*	0.16	0.19	-0.22	0.22*	0.23*	0.07		0.19*	-0.34*	0.17*	-0.09	0.01	0.06	0.10*
L	0.36	-0.27	0.68*	0.07	0.59*	0.51*	0.26**		0.59*	0.04	0.27	0.36*	-0.09	0.44*	0.55*
H	0.04	0.04	-0.05*	0.16	0.03*	0.01	0.01		0.02	-0.00	0.01	-0.01	-0.00	0.01	-0.00
Intercept	1.98*	1.82*	0.96*	-1.52*	1.08*	0.08	0.95*		1.21*	-0.22*	-0.75*	3.46*	0.44	0.38*	0.11*
Mean group estimator															
Long run coefficients															
K	0.48*	1.57*	0.39*	0.35	0.14	-1.12	0.16	0.02	-0.36*	0.50*	0.23*	0.16	-4.17	-0.00	0.29
L	-1.10	-0.35	-0.31	-0.44	0.21	-4.50	2.25	0.09	1.01	0.42*	0.56	0.83	1.88	-0.17	-3.83
H	-0.04	0.02	0-.02	0.03*	0.04	0.12	-0.17	0.10	0.08*	0.01*	0.01	0.00	-0.12	-0.10	0.15
EC	-0.57*	-0.57*	-0.47*	-0.38	-.039	-0.31*	-0.49*	-0.17*	-0.43*	-.069*	-0.49*	-0.51*	-0.26	-0.30*	-0.34
Short run coefficients															
K	0.27	-0.42**	0.07	-0.21	0.21*	0.11	0.03	0.14*	0.21*	-0.45*	0.10	-0.06	0.07	0.13	0.03
L	0.32	-0.02	0.65*	0.29*	0.43*	0.68*	0.47*	0.71*	0.50	0.06	0.32	-0.13	-0.00	0.45*	0.58*
H	-0.03	0.05	-0.02	0.16	0.05	-0.01	0.02	0.02	0.01	-0.00	-0.03	-0.01	-0.01*	0.00	-0.00
Intercept	5.77	-0.74	2.03	2.44	2.30*	2.78**	2.47*	2.16	2.61*	0.93	2.97*	-0.65	3.30*	2.56*	1.35
Hausman test	1.08	14.83*	3.49	10.84*	-176.25***	-2.79***	7.28*		3.56	77.74*	4.95	44.14*	-0.72***	6.82**	4150.09*

* significant at the level of 5%

** significant at the level of 10%

*** asymptotic assumptions of Hausman test violated

****optimization routine could not be iterated for the PMG estimation due to the issue of non-concavity