Intangible Capital and Productivity Growth since Globalisation: A Cross Country Analysis

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ABSTRACT

This paper is concerned with the determination of relative roles of intangible ,tangible and human capital and also of TFP on the growth of real GDP for a set of EU countries and JAPAN and USA. We estimate the share weighted growth contributions of intangible, tangible, human capital and that of total factor productivity to the growth of real GDP by undertaking country specific growth accounting analysis. It uses both the production elasticities of factor inputs and also the user cost of factor services as share weights for computing the share weighted growth contributions of factors in separate growth accounting analysis .We use neo classical well behaved MFP function to this end .We also undertakes the cross country growth accounting analysis.

It is found that the intensity of the use of intangible capital as compared to that of tangibles has increased sharply over the period in a good number of countries. We find that the inclusion of intangible capital and the human capital reduces the relative contributions of tangible capital, labor and TFP to the growth of GDP of the countries in varying degrees. Our dynamic panel regression results also confirm the statistically and economically significant roles of the three capitals in the cross country variations in the growth of real GDP across the countries. We find diverging tendency across our sample countries.

Key Words: Country Specific Growth Accounting; Cross-Country Growth Accounting ; EU Countries; USA and Japan; Dynamic Panel with GMM..

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1. Introduction

It is undeniable that the production of goods and services of the economies across the globe are gradually being increasingly dependent on the knowledge capital. This is being reflected in rapid transformation of the nature of investment component of GDP which basically acts as the main driver of growth of an economy through the increase in the labour productivity growth which in turn depends on the capital used per unit of labor . In fact, the dramatic change in the business investment climate has been overwhelmingly reflected in increasing investment in knowledge capital i.e. the intangible capital having no physical form undertaken by both the business and public sector of the economies as compared to that of tangible capital since the last two decades. It is also true that some of the tangible investments like ICT equipments viz; computer, hardware, communication equipment also has been acting as the main driver of the changing in investment scenario across the countries. Actually in this dynamic world of revolution of information and communication technology (ICT) and artificial intelligence (AI) the nature of investment done by business and public sector of the economies has been so fast changing that the countries in the globe are being increasingly inclined to intangible capital relative to tangible capital so as to achieve high rate of growth of national

output as well as labour productivity through the optimal utilization of their productive base. As a fall out an intense competition between the intangible capital rich countries and the tangible capital rich countries in the globe has also been cropped up for achieving highest rate of growth of real output per capita. Further, as a result of this tremendous expansion of the knowledge economy the knowledge content in goods and services produced in the economies is also increasing precipitously. It is also undeniable that the liberalization of trade, investment and finance due to globalization has subserved this process of switching over to the tendency of maximal use of the intangible capital relative to a tangible capital especially in the developed countries where infrastructure and stock of human capital are higher. Further as complimentary to the liberalization, increasing relaxation on the regulations on the labor and product markets in majority of the large countries in the globe has encouraged the business sector to increase the rate of use of the intangibles. Surprisingly, despite the increasing trend of capital deepening process (tangibles and intangibles) which is the main driver of growth a declining trend in the labour productivity growth in the developed countries especially UK,USA, Japan , France and Germany etc. during the period 2008-2013 with a bit recovering tendency from the 2014-2017 has been detected by the economists (Van Ark and Jager, 2017; Stehrer et. al.,201;, Corrado et. al. ,2012,2018; Ruth,2019; Van Ark, Brt et. al. 2009). All these have drawn attentions of the economists on the judging the relative roles of tangible and the intangible investment on the labour productivity growth of mostly the developed countries.

Therefore the quest for the quantitative estimations of intangible capital consisting of computerize information, innovative property and economic competencies and its contribution to the real GDP as well as growth of labour productivity across the developed countries in the globe has ceased the attention of the economists and

researchers since last two decades. Unfortunately, before the pioneering research work on the development of coherent framework for quantitative estimation of business intangible capital and its contribution to output, labour productivity and their possible inclusion in the system of national accounts done by Corrado, Hulten and Sichel (CHS,2005), all kinds of intangible assets and their value addition to nations' aggregate output were not included in the system of national accounts. The components which had been taken into account were the computerized information (software and database development), the innovative property (viz; mineral exploration, copyright license cost, scientific and engineering R &D). So, the new intangibles like deign and other product development cost under the category of innovative property, and Training, Market research and design expense (namely, brand equity, farm specific human capital and organizational structure) in the category of the economic competencies were excluded from national accounts. This has unveiled the lacuna in the estimation of GDP caused by the non-inclusion of the fraction of the value added by the said intangible investment done by the business , manufacturing and other sectors in the economy. One reason for this non-inclusion seems to be the non- exposer of the investment expenditures on such intangibles by the corporate business houses in their company balance sheets.

Consequently a host of economists have devoted themselves in the explicit estimation of the gross value added by all intangibles at the country level and cross country level especially for the developed EU countries and UK, USA (Corrado, Hulten and Sichel (CHS,2005, 2009); Nakamura 2001, Nakamura 2010;Haskel and Westlake, 2018;Goodridge,et.al, 2016,Van Ark and Jager, 2017; Syverson 2017; Corrado et. al. ,2012, 2016,2018; Ruth,2019; Van Ark, et. al. 2009). Alongside several working Groups viz; OECD, EU KLEM , INTAN-Invest have estimated the stock of intangibles and published their database on line.

After the publication of these estimates some of the developed countries are including the capitalization of software, investment in entertainment, and literary and artistc originals in their national accounts (Haskel and Westlake,2018).

Interestingly, the literature to this area has gradually been mounted up since last two decades. Mainly four broad categories have come on to the surface viz; the country level studies (CHS, 2009; Hulten and Hao,2012;Haskel and Westner,2018; Mac Clure,2009;), cross country growth accounting studies (Hao et.al, 2009, Van Ark et.al,2009; Corrado et.al,2013), the firm or industry specific studies concentrating in single country and across the countries (Battisti et .al,2015; Miyagawa and Hisa,2013; Chun and Nadiri,2016; Goodridge et`.al 2013 , Corrado et.al.,2016)and the Sector specific studies (Barnes,2010, Fleisher et.al,2015; Mc Grattan , 2020;Krishna et.al , 2018) . Most of these studies have tried to estimate the intangible capital and its role to the gross value added and also to the labor productivity growth and TFP growth coupled with some studies which in addition to this have concentrated on the development of suitable and meaningful framework to capture the different categories intangible capital and its value additions at the country level , firm level and also at the sectoral level (Corrado, Hulten and Sichel (CHS,2005, 2009) Van Ark et.al, 2009;Nakamura 1999,2001, Roth and Thum, 2013, Haskel and Westner,2018; Neibel et.al 2017; Marrocu et.al, 2012,). There are few studies amongst the studies stated above which have tried to account for the declining trend in labor productivity and tfp growth (Ark and Mahony, 2016, Haskel and Westner,2018; etc).

However almost all these studies have tried to capture the relative role of the intangible investment on the on the labor productivity growth and some have tried to estimate role of the intangibles on the TFP growth through growth accounting

considering the supply side of the national income accounting identity without taking into account of the pivotal complimentary role that the human capital plays through its contribution to the growth of the real GDP and TFP growth of the economies. In fact for the efficient utilization of the knowledge capital and also the non ICT based intangibles either domestically produced or imported the efficient and enriched stock of human capital and its services are quintessential. In fact it plays a direct role and the indirect complementary role to the productivity growth, and growth of total as well as sectoral output growth. So the non inclusion of human capital may lead to the estimation bias.

Under this backdrop we proceed to undertake country specific growth accounting exercise and the cross country growth accounting exercise by considering human capital along with labor, physical capital and the intangible capital as arguments in the multifactor production function analysis for a set of total 20EU countries and Japan and USA (**appendix-I**) which data on all the actor inputs are available for the period under consideration. Our study centers round the following questions: what is the contributive impact of the IC on the growth of aggregate output of the countries ? Does the inclusion of H effect the growth contributions of labor(L) , Physical capital (K) and IC? What is the impact of the IC in combination with the other factor inputs on the TFP growth? What relative roles these four factors play on the cross country variability of the productivity growth over the period? Is there an tendency of the countries using IC to converge to their steady state growth?

The rest of this paper is designed as follows. Section –II gives brief description of the research design and data base used in this study; Section –III highlights the nature of the changing structure of the investment in the sample countries :

Section –IV presents the results of our country specific growth accounting exercises; Section VII displays the analytical part of the cross-country growth accounting results estimated through the dynamic panel regression with GMM technique and finally the section VIII presents the concluding observations.

II. Research design and Data Base.

There are two most commonly used methods based on the Solow residual concept for estimating the total factor productivity growth and the growth contribution of factor inputs to the growth of total output either at the industry or firm level or country level or sectoral level. By the first method initially the production elasticities of factor inputs are determined through production function analysis and then the same are used to find out the share weighted growth contribution of the factor inputs and that of the total factor productivity (tfp).

The second method centers round the estimation of factor cost (user cost) share weighted growth contribution. In this method the user cost of each factor service is expressed as ratio of the total cost of the factor service and then these ratios are used as weight for computing the growth contribution of each factor as well that of tfp to the growth of total output. In our study we have used both of these methods for estimating the tfp and the factor contributions.

While using the first method for computing the growth contribution of the factors we use conventional multifactor neo-classical production function (MFP) of Cobb-Douglas type containing four factor inputs labour (L), physical capital (K), intangible capital (I) and human capital (H). We have done country specific regression analysis for determining the respective production

elasticities of the factors and then compute the share weighted growth contribution of the factors to the growth of aggregate output, weight being the elsticities of output with respect to each input which under competitive condition are measured by their factor shares. Then by using the methods of Solow residual we compute the tfp growth. When we use the second method we compute the user cost share of each of the four factors i.e. of factor service of each factor to the total factor cost for producing total output. Then we use this user cost shares for computing the cost share weighted growth contribution of each input and also tfp growth to total output such that the sum of the share weights be equal to unity. After computing the country specific year to year growth of output, year to year share weighted growth contribution of the factors and that of tfp we take simple averages of these contributions over the years that gives us the average productivity growth and the growth contributions of the factors and tfpg of the respective countries.

We have also done the cross-country growth exercise by using the dynamic panel regression analysis. We proceed as follows.

The traditional neo-classical model of growth accounting decomposes the growth of GDP of any economy over time in terms of the growth contribution of capital (K) , Labour(L) , Human Cpital (H) and the contribution of exogenous technology(A)i.e. the total factor productivity growth(TFPG) or the productivity growth such that the unknown component TFPG is computed by taking the difference between the growth of real GDP and the sum of the growth contributions of all the factor inputs through the use of the MFP. The literature concentrating on finding out the explanations behind the steady slowdown behind the labour productivity growth of the developed countries have highlighted on two

factors namely the fall in the total factor productivity growth and the increased use of ICT, AI i.e. the intangible capital. So, the measurement of TFPG without the inclusion of intangible capital produces upward bias in the estimation of the TFPG of the countries. But none of the studies outline the role of human capital on the growth of output albeit the human capital helps directly and indirectly the efficient use of factors and the intangible capital also there by contributing to the productivity growth and growth of output. So, to estimate the role of intangible capital on the growth of GDP and the productivity growth we use the standard growth accounting methodology by considering an aggregate MFP using the stock of intangible capital and also the human capital as arguments, along with the labor and physical capital in the MFP. In fact the real output and all the real factor inputs are accurately accounted for then the growth of TFP are likely to be negligible over time (Jorgenson and Grilliches, 1967) across the countries.

We use standard neo-classical well behaved aggregate production function i.e. one sector production technology producing composite output i.e. real GDP (Y_{it}):

$Y_{(it)} = A_{(it)} F(L_{(it)}, K_{(it)}, I_{(it)}, H_{(it))}$ .....(1)

Here i = 1 ..... 22 countries

t = time period 1995 2019

Where Y = Real GDP (at 2015 constant LCU)

L = Labour measured in terms of aggregated labour hours used in the production process

K = Stock of physical capital (expressed at 2015 LCU)

I = Stock of Intangible capital (at constant 2015 LCU)

H = Stock of human capital estimated at constant 2018 US$ PPP

A = Measure of the TFP.

We assume that (i) the production function obeys constant returns to scale; (ii) there is perfect competition in both factor and commodity market such that price equals marginal cost and factor prices are equal to their marginal production. This amounts to assume the hypotheses of Euler's theorem. So it is clear that production function is homogeneous of degree one i.e. sum of the production elasticities is equal to unity. Now assuming a Cobb- Douglas form of production technology we write: $Y = A_t K_t^{\beta k} L^{\beta L} H_t^{\beta h} I_t^{\beta i}$ .....(2)

Taking logarithmic transformation of the production function, the relationship for long term growth can be expressed as

$\log Y_{lt} = \log A_t + \beta_k (\log K_t) + \beta_L (\text{Log } L_t) + \beta_h (\log H_t) + \beta_i (\text{Log } I_t)$....(3)

Where β values will represent the production elasticities of the respective factor inputs which we estimate from the real input data set by applying least square regression method for each of our sample countries separately by regressing Log Y_t (i.e. the dependent variable) on the log of the real values of factor inputs.

So the country specific regression equation becomes

$\log Y_t = \alpha + \beta_j \log X_j + \epsilon_t$ .....(4)

Where β_j are the row vector of factor coefficients or the production elasticities and

X_j = row vector of factor inputs: j=1…4.

ϵ = error terms

After determining the values of coefficients (β_j) i.e. the production elasticites of the factor inputs, we compute the share weighted growth contribution of the factors by multiplying the year to year growth of factors by their respective production elasticities. We also compute the year to growth of real GDP : $(\Delta Y/Y) = (Y_t - Y_{t-1})/Y_{t-1}$ but the components of TFPG remains unknown. So for computing TFPG for each year we take the sum of the growth contribution of factors (X) i.e. $\sum^4_{J=1}\beta_j (\Delta X_j / X_j)$, and we subtract the total growth contribution of factors from growth rate of real GDP such that: $TFPG_t = \Delta Y_t / Y_t - \sum\beta_j (\Delta X_j / X_j)$. Here the important assumption is that the production elasticity factors remain constant overtime. After having the year to year growth of real GDP and growth contribution of individual factor including the TFPG for each year of the total period, we take the cross time sum of the factors contributions TFPG and year to year real GDP growth and then take simple average of the cross time growth contributions of factors, TFPG and growth rates of GDP. Therefore, the country specific average rate of growth of aggregate output (GDP) becomes the weighted average of the rate of growth contributions of the factor inputs. The weights are the elasticities of the output with respect to each input which in competitive conditions are measured by their factor shares.

Thus we have the country specific average growth contributions of the factors and TFPG for each country over the period. This exercise is done four times by following the same method: one with 'I' as arguments in the production function along with K, L, and H and this gives us TFPG by taking into account of the role of intangible capital and human capital on productivity growth as well as growth of real GDP of the sample countries over the period under consideration. The other exercise is done by using production function without inclusion of 'I' as argument

in the production function so that we have the TFPG contribution to growth of real GDP for each country without intangible capital. Then we compare the TFPG with 'I' as argument in production technology and TFPG without 'I' as argument, so that we may have a distinct or explict insight about the role of 'I' not only in the average productivity growth of the countries but also on the average growth of real GDP as well as the growth contribution of other factor inputs. Again we do the same exercise by dropping "H", cet.par. However, a crucial problem with the growth accounting has been that technological progress often become embodied in new capital goods such that it becomes difficult to separate the influence of capital accumulation from that of innovation . In such case the role of human capital becomes prominent. So TFPG is likely to be influenced by the human capital deepening component of capital. Jorgenson (1995) has done similar study for OECD countries. It has also been found that if we take into account the accumulation of physical capital and human capital in MFP then TFPG falls to about 30% of economic growth (Aghion and Howitt(2010) . So to have a distinct insight about the contribution of human capital to growth and TFPG we have done third growth accounting exercise by using the MFP excluding the human capital as argument. Finally, we have done cointry specific growth accounting exercise by considering only labor and physical capital in the MFP.These four growth accounting exercises are done for each of the countries in our panel. The results of all the exercises are given in text tables. It is worth mentioning that we he have chosen our sample countries along with period of analysis for the panel exclusively on the basis of the availability of the country specific longitudinal data base on all the factor inputs and the pertinent factors required for our estimations.

We have also done country specific user cost share weighted growth accounting exercises such that contributions of each factor such as labor, capital , human

capital and intangible capital are estimated by multiplying the rate of change in the factor inputs weighted by their user cost shares to total input cost of production of total output of the economy. For user cost share weighted growth accounting we consider the same neo-classical production function (I)

To decompose the growth the growth of output we take log differences as

$$\Delta \log Y_{lt} = \Delta \log A_t + s_k \Delta \log K_t + s_L \Delta \text{Log } L_t + s_h \Delta \log H_t + s_i \Delta \text{Log } I_t \text{.....(4)}$$

Where the s_j(j=1..4) are the respective user cost shares to the total user cost or the factor service cot such that the sum them equals unity in each case.This iswhat follows from the supply side of the national income accounting.

To compute the user cost shares we use the Pen world tables, version 10 where the longitudinal data on compensation for labour and physical capital and the real GDP across the countries are available. Since there is no separate estimate for the compensation to human capital we have estimated the service cost or the user cost share of human capital as follows. We take the sum of the total expenditure on the secondary and tertiary education of the respective countries as user cost of human capital of the countries. The data on the expenditures on the intellectual property payments are given in the world Bank data base at current US dollars. We have expressed these at constant 2015 us dollar and use this expendirure as proxy of compensation to intangible capital of the countries. Then we take the sum total of the service or user costs of human capital and intangible capital and deduct the same from the series of GDP .Then we distribute the remnant part of the GDP as compensation to labour and physical capital by using the ratio of labor compensation and capital compensation originally given in the Penn world table and express them as percentage of GDP. In this way we estimate the total cost of factor services and express the user cost of each factor as ratio to total cost . This

gives us the user cost shares of each factor for the period for each country such the sum of the cost shares be always equal to one. We repeat same process when we drop factor input from MFP and have the respective user cost shares (s_j)of the factors under consideration in the new MFP. Using these cost shares as weights to the growth of each input we compute the share weighted growth contributions of the factor inputs.

Now for the simultaneous cross country and cross time growth accounting exercise i.e. to find out the effects of cross country and cross time variations in the growth contributions of the four factor inputs including the intangible capital on the cross country variations in growth of real GDP we use the same production function (equation -2) with the replacement of Y, L, K, H, I, in per capita (person employed) terms and take the log differences of the per capita output(GDP) and per capita factor inputs. It will also help alleviation of the multi co-linearity problem between the arguments.

So the growth accounting equation becomes:

$(\log y_t - \log y_{t-1}) = (\log A_t - \log A_{t-1}) + \beta_l (\log l_t - \log l_{t-1}) + \beta_k (\log k_t - \log k_{t-1}) +$

$\beta_h (\log h_t - \log h_{t-1}) + \beta_n (\log i_t - \log i_{t-1}) + (\log €_t - \log €_{t-1})$……..(5)

Here the term in the left hand side indicates productivity growth

We use the dynamic panel exercise with GMM technique for the cross country growth accounting for the two panels of countries to estimate the contribution of all the three types of capitals and labor. Interestingly to examine whether countries are experiencing the converging and diverging tendency in respect of variations of growth rates caused by the variation the growth of natural capital, physical capital, human capital and labor we conduct the same dynamic panel exercise by including the base level of log per capita GDP ($\log y_0$) as an argument in the growth accounting equation.

Econometric Specification of the cross country growth accounting.

To estimate the cross-country variability in the growth contributions of L, K, H and N on the variability of per-capita growth of output over time, we use the dynamic panel regression with GMM estimators of Arellano- Bond for both the panels of developed and developing countries separately. The simplest model introduced by Arellano and Bond (1991) which we use can be expressed as

$$\ln Y_{it} - \ln Y_{it-1} = (\alpha-1) \ln Y_{it-1} + \beta \ln X_{it} + u_i + \varepsilon_{it} \qquad (6)$$

Where, i = 1,2,3…..,22

t= 1,2,……T (year) i.e. from 1995 to 2019; .

Here, $\ln Y_{it}$ represents the dependent variable i.e. the per capita real GDP; $\ln X_{it}$ represents the vector of explanatory variables (other than lag dependent variables) i.e X_{it} is a (K-1)x1 vector of exogenous regressors viz; the per capita labour hour, per capita physical capital, per capita human capital, per capita intangible capital; u_i stands for unobserved country specific effect i.e. the fixed effect and ε_{it} is the conventional error term such that $\varepsilon_{it} \sim N(0,\sigma^2)$ i.e. the random disturbance term.

We rewrite the eq(1) as

$$\ln Y_{it} = \alpha \ln Y_{it-1} + \beta \ln X_{it} + u_i + \varepsilon_{it} \qquad (7)$$

Now to eliminate the country specific effect (u_i) we take the first difference of equation (2) such that we have the dynamic panel model with GMM estimator as

$$\Delta \ln Y_{it} = \alpha \Delta \ln Y_{it-1} + \beta \Delta \ln X_{it} + \Delta \varepsilon_{it} \qquad (8)$$

So, the fixed effect (i.e. country specific effect) is eliminated. By construction ΔY_{it-1} is correlated with $\Delta \varepsilon_{it}$. Now the use of instrument is required to deal with (6)

containing the likely endogeneity of the explanatory variables all the capital stocks due to their accumulative nature and also (7), the problem that the new error term in eq-8 is correlated with the lagged dependent variable (by construction). Under the assumption that there is no serial correlation in ε_{it} and the explanatory variables X are weakly exogenous, the GMM dynamic panel estimator uses the following moment conditions

$$E[\ lnY_{it-s}\ (\varepsilon_{it} - \varepsilon_{it-1})] = 0 \qquad \text{for } s \geq 2;\ t = 3,4,\ldots\ldots\ldots\ldots..T\ldots\ldots\ldots\ldots\ldots(9)$$

$$E[\ lnX_{it-s}\ (\varepsilon_{it} - \varepsilon_{it-1})] = 0 \qquad \text{for } s \geq 2;\ t = 3,4,\ldots\ldots\ldots\ldots..T\ \ldots\ldots\ldots\ldots\ldots(10)$$

Now it follows that if the regressors are strictly exogenous, ε_{it} can not affect X_{is} for any s or t. Again if regressors are pre-determined, ε_i may affect for X_{is} for $s > t$. Strict exogeneity rules out any feedback from the idiosyncratic shock at time t to a regressor at time $s > t$.

It is worth noting that the consistency of GMM estimators depends on the validity of the instrument which produces their impact on the dependent variable through the regressors. To deal with this issue we need the specification test. In our study we use the Sargan test of over identifying restrictions which actually tests the overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process.

Data Base

In our study we use the secondary data base which are available from Penn world table 10.0 version, EU KLEMS and INTANProd data base, World bank Data base .The data on stock of human capital are taken from the Changing Wealth of Nations 2021 data base of World Bank . 7The data set on the real GDP of our sample countries are taken from World Bank Data Base such that the GDP across

the countries are expressed at constant 2015 US dollar PPP. The data on the labour force employed in the production of GDP are measured in terms labour hours and these data are taken from Penn world table 10.0 version.

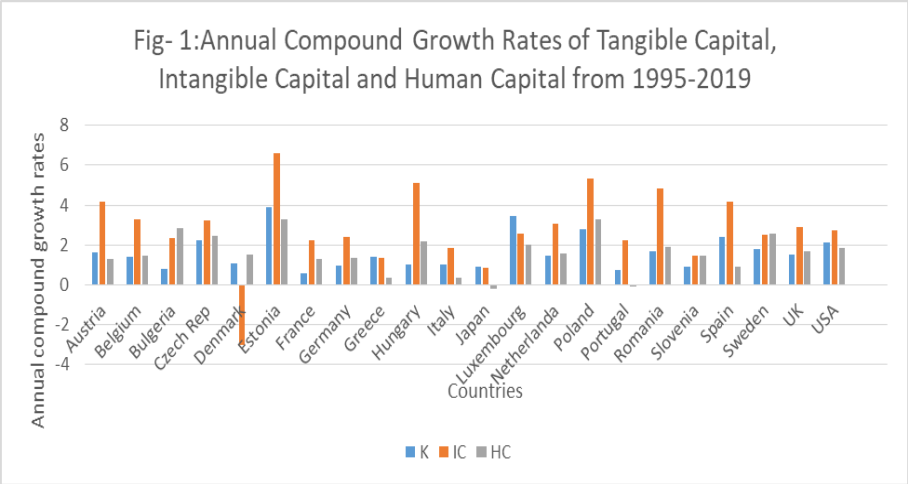
Here the stock of human capital of each country includes the knowledge, skills and experience embodied in the workforce and is estimated as the total present value of the expected future labor income that could be generated over life time of the men and women currently living in a country. The lifetime income profiles for a representative individual are multiplied by the corresponding number of people in a country and thus the stock of human capital by age, gender and education is computed. The sum of these stocks of the human capital across all classified categories gives the estimate of the aggregate value of stock of human capital of each country. More specifically the total stock of human capital of a country is the sum of the product of the present value of life time income for an individual by age, gender and education and the population in same age, gender and education level.

III. Nature of the changing structure of the investment in the sample countries

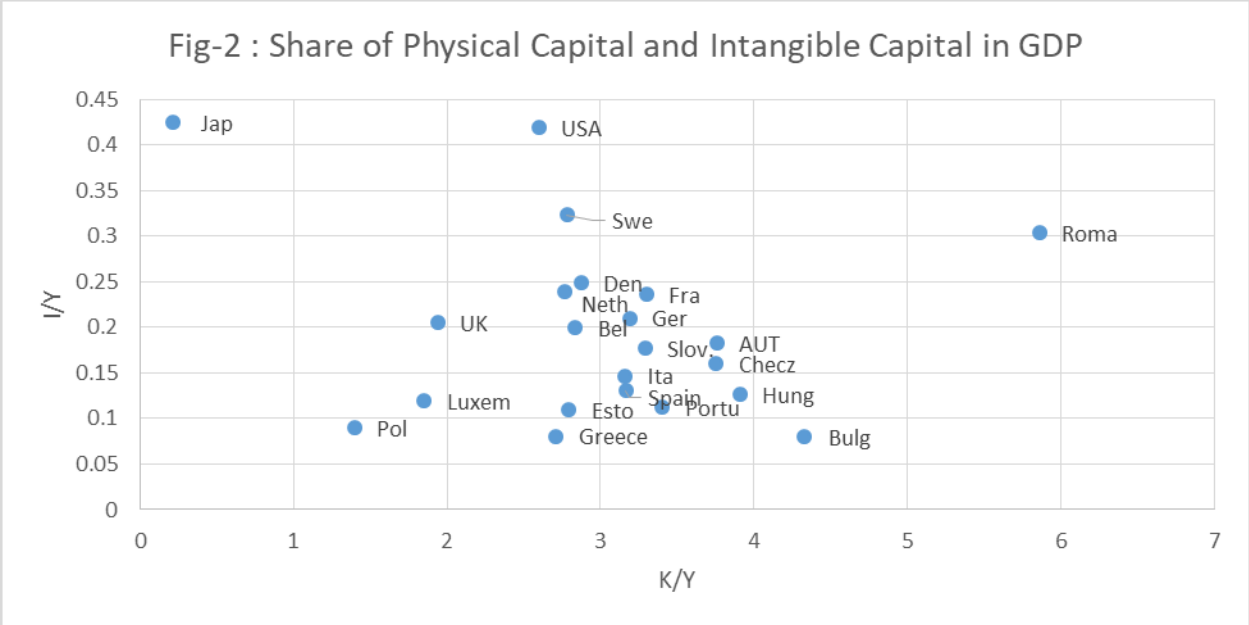
It is undisputable and it has also been viewed in an increasing number of studies that there has been spurt in labour productivity growth as well as growth of GDP in the developed countries during the period 1995-2005 which has been accompanied by a rapid slowdown in the growth of labour productivity per hour during the period 2005-2018 such that the same has become almost halved in majority of the developed countries. The possible explanations given so far are that this downturn is mostly driven by the decline in tfp and the capital deepening. In fact most of the countries in our sample have experienced structural transformation in the production structure as well as investment structure and even there has been shifting of

resources from low productive sector to high productive sector. The countries that we have taken in our sample have experienced growth of their GDP driven mostly by the service sector such that the contribution of service sector in the countries like Japan, Luxembourg, Italy, USA, UK etc. range from 62% to 78%. The structural transformation in the investment is reflected in the annual compound growth rate of tangible capital, intangible capital as well as human capital. The figure I demonstrate the growth rates of this three and it is clear that in most of the countries the growth rates of intangible capital as compared to that of tangible capital are much higher over the period 1995-2019. So we can plausible in the process of capital deepening the intangible capital occupies prominent place. The scatter plot given in figure-2 gives country specific tangible and intangible capital intensities in terms of the share of their GDP. It is evident that the average relative intensities of intangible capital (I/Y) corresponding to that of tangible capital (K/Y) are high in Japan, USA, Sweden, UK, Denmark, Romania, France followed by the other countries. Therefore it can be viewed that capital deepening across the countries has taken place largely in terms of intangible capital. The intensity of use of intangible by other factors is found to increase across the countries (see Appendix-A).

If we compare this intensity in terms of its share in GDP of the countries with respect to our estimated tfp growth over the period in our study then the line diagrams clearly reveal an increasing intensity of use of intangible capital across the countries , while the TFP growth exhibits very lower rates accompanied by year to year fluctuating pattern **(see appendix-II).**



Source :Authors' Construction



Source :Authors' Construction

IV. Country specific growth accounting Results

This section reports the results of our growth accounting exercise in two parts A and B. **Part A** presents the growth accounting results in which case

we compute the share weighted growth contributions of the factor inputs using respective production elasticities as factor shares such that these are estimated by country specific regression analysis of the MFP. We undertake phase wise estimation of the relative contributions of the factors as source of growth of GDP. First we include all the four inputs in MFP (results of which are reported in table-1); and then we drop human capital keeping other factors unchanged (results of which are given in table-2); thereafter we drop both human capital and the intangible capital from the production function analysis and estimated the relative growth contributions (table-3) and finally we drop the intangible capital only keeping others unchanged for evaluating the relative importance of human capital in absence of intangible capital(results of which are reported in table4). All these exercises are done to examine how the relative importances of these factor inputs as well as the total factor productivity in their contribution to economic growth i.e. changes with the phase wise dropping and inclusions of factors in the MFP. **Part B reports** the results of similar exercises when we compute the factor cost share weighted growth contributions.

PART A

From the Table 1 it is evident that the average contributions of intangible capital to the growth of GDP are positive in most of the countries ranging from 0.02% in USA to 4.14% in Poland while it is negative in some countries including Austria (-0.36%), France (-0.04%) UK. However, the same of human capital are found to be positive in 13 countries and that of labour are found to be positive for majority of the countries. Now, if we look at the contribution of TFPG in table 1 we find it to be negative for

majority of the developed countries. It seems to be due to the inclusion of human capital and intangible capital in the MFP. Further, the inclusion of intangible capital along with human capital has led to the negative contribution of tangible capital in 9 out of 22 countries**.** So it is plausible to conclude that simultaneous inclusion of human and intangible capital in MFP has weakened not only the contribution of tangible capital and labour but also that of TFP.

If we compare this results with that is given in table 2 where we drop the human capital keeping others in MFP we find that it has reduced the contribution of labour and intangible capital in varying degrees across the countries such that the contribution of intangible has become negative in 7 countries (UK, USA, Franc, Netherlands etc.) in our sample. This clearly signifies that there is both direct and indirect role of human capital in efficient use of intangibles and labour. Surprisingly, contribution of TFPG remain negative in same in 12 countries out of 14 countries in table 1 with the same being positive in UK , USA and Bulgeria. Now if we consider the results of the growth accounting exercise given in table-3 considering only labour and tangible capital then we find the substantial improvement in the contribution of physical capital and mild improvement in that of labour in varying degrees across the countries. Interestingly in most of the countries the contributions of tfp has improved a lot albeit it shows very poor negative values for few countries. This clearly indicates that ignoring the intangible assets we actually over state the tfp growth or multifactor productivity growth as well as the growth contribution of tangible capital and labour**.** Further, if we drop intangible capital and include human capital along with labour and tangible capital in MFP we find mixed results of it on

contribution of tfp, capital and labour such that large number of countries experienced improvement in the contribution of tfp,labour and tangible capital to growth of the GDPs in varying degrees. This clearly establishes that the human capital influences the contribution of tfp growth and that of labour and capital there by indicating that countries human capital plays an important role in the efficient utilization of their productive base.

Table-1 : Results of Growth Accounting With Human Capital and Intangible Capital for Selected Countries During 1995-2019.

Country	GGDP (%)	CL(%)	CK(%)	CI(%)	CH(%)	TC(%)	TFPG(%)
Austria	1.84	0.404255	1.940479	-0.36766	-0.03033	1.946745	-0.10412
Belgium	1.88	1.117339	0.017121	0.9415	-0.24571	1.830247	0.045919
Bulgaria	2.34	0.387639	0.44668	0.660078	1.991958	3.486356	-0.07236
Czech Rep	2.65	-0.0989	-0.00479	2.550677	0.143132	2.59012	0.060755
Denmark	1.66	0.300376	0.251699	0.001757	0.302803	0.856635	0.80674
Estonia	4.28	0.081547	1.662777	0.031409	1.624176	3.399909	0.302869
France	1.64	1.006493	0.791321	-0.0479	-0.02403	1.725888	-0.08626
Germany	1.4	0.303069	0.699979	0.476804	-0.02801	1.451838	-0.0495
Greece	0.885	0.192233	0.284111	0.066751	0.313759	0.856854	-0.03116
Hungary	2.63	0.159928	-0.74323	2.034198	1.281717	2.732616	-0.18431
Italy	0.614	0.318645	-0.03203	0.364405	-0.03251	0.618517	-0.00568
Japan	0.805	-0.16766	-0.30559	1.151694	-0.05631	0.622129	0.226306
Luxembourg	3.37	6.062417	-1.15084	0.180725	-1.65628	3.436021	-0.0608
Netherlands	2.02	1.273114	1.47953	-0.04675	-0.50084	2.20506	-0.18185
Poland	4.11	-0.05166	-1.05405	4.140456	0.8389	3.873642	-0.12848
Portugal	1.43	-0.17911	0.076749	0.731659	0.047798	0.677101	-0.02132
Romania	3.22	0.728433	1.036007	1.018416	1.869624	4.652479	-0.53719
Slovenia	2.76	0.124377	-0.08992	1.331659	0.953183	2.319303	-0.08662
Spain	2.17	1.261917	-0.50655	1.557285	-0.14659	2.166066	0.020239
Sweden	2.5	0.161218	-1.5997	2.914354	1.114836	2.590709	-0.04753
UK	2.08	0.989775	1.471064	-0.42233	0.138694	2.177204	-0.1005
USA	2.47	0.1045	1.797317	0.020654	0.524111	2.446582	0.027376

Source: Author's Computation. CL,CK,CI and CH=contribution of labour, capital, intangible capital and human capital, GGDP= growth rate of GDP

Table-2: Results of Growth Accounting with Intangible Capital and without Human Capital for Selected Countries during 1995-2019.

Country	CL(%)	CK(%)	CI(%)	TC(%)	TFPG(%)	% point difference between TFPG in Table-1 and 2
Austria	0.397223	2.038719	-0.49256	1.943385	-0.10076	-0.00336
Belgium	0.87923	0.297012	0.63965	1.815891	0.060275	-0.01436
Bulgaria	0.259221	0.814377	2.151359	3.224957	0.189043	-0.2614
Czech Rep	-0.1016	0.129892	2.541009	2.569302	0.081573	-0.02082
Denmark	0.426655	1.025492	-0.00055	1.4516	0.211775	0.594965
Estonia	0.18408	5.933277	-2.87428	3.243072	0.459705	-0.15684
France	1.001655	0.814448	-0.11488	1.701227	-0.0616	-0.02466
Germany	0.289407	0.728905	0.418672	1.436983	-0.03465	-0.01485
Greece	0.454061	-0.32361	1.200614	1.331061	-0.50537	0.474207
Hungary	0.118491	0.450669	2.13993	2.709089	-0.16078	-0.02353
Italy	0.301099	-0.0636	0.376703	0.614198	-0.00136	-0.00432
Japan	-0.13752	0.04171	0.688538	0.592731	0.255704	-0.0294
Luxembourg	4.425275	-1.05508	0.107296	3.477489	-0.10227	0.041468
Netherlands	1.005474	1.37738	-0.29812	2.084738	-0.06153	-0.12032
Poland	0.049275	-1.42756	5.225663	3.847376	-0.10221	-0.02627
Portugal	-0.15978	0.014403	0.817497	0.67212	-0.01634	-0.00498
Romania	-0.07867	2.254797	2.336721	4.512846	-0.39755	-0.13963
Slovenia	0.474093	0.365237	1.475388	2.314718	0.092176	-0.17879
Spain	1.028756	-0.57236	1.699909	2.156308	0.029997	-0.00976
Sweden	0.23062	-0.5805	2.971134	2.621256	-0.07807	0.030547
UK	0.748677	1.408468	-0.09297	2.064179	0.01253	-0.11302
USA	0.26888	2.500211	-0.30328	2.465809	0.008149	0.019227

Source: Author's Computation.

Table-3: Results of Growth Accounting without Intangible Capital and without Human Capital for Selected Countries during 1995-2019.

Country	CL(%)	CK(%)	TC(%)	TFPG(%) (C)	% point difference between TFPG in Table-2 and 3
Austria	1.098516	1.312696	2.411212	-0.78121	-0.680452087
Belgium	0.864309	1.421176	2.285484	-0.22548	-0.285759679
Bulgaria	-0.04162	0.377968	0.33635	2.00E+00	1.814606901
Czech Rep	0.036566	2.595271	2.631837	0.063734	-0.017838588
Denmark	0.431981	0.86031	1.292291	0.300362	0.088586883
Estonia	0.158369	3.111135	3.269504	1.01E+00	0.550790099
France	0.968678	0.739595	1.708273	-0.05171	0.009894456
Germany	0.459017	1.009579	1.468596	-0.0426	-0.00794557
Greece	1.133716	0.141162	1.274878	-0.5312	-0.025831125
Hungary	0.132861	2.423623	2.556484	0.107653	0.268437836
Italy	0.28332	0.168183	0.451503	0.130149	0.131514037
Japan	-0.00874	0.663493	0.654754	0.083155	-0.172548427
Luxembourg	4.782348	-1.2704	3.511945	0.022817	0.12508821
Netherlands	0.837265	1.127156	1.964421	-0.00107	0.060456735
Poland	0.535392	2.627902	3.163293	0.571873	0.674082597
Portugal	-0.15087	0.403873	0.253003	0.27135	0.287692358
Romania	2.124974	1.169143	3.294117	0.514707	0.912258272
Slovenia	0.551604	1.322186	1.873791	0.533104	0.440927823
Spain	0.928446	1.094002	2.022448	0.142779	0.112782321
Sweden	-0.13545	2.493789	2.35834	0.232136	0.310209529
UK	0.711653	1.307182	2.018835	0.046426	0.033896703
USA	0.248284	2.163867	2.412152	-0.02628	-0.034431311

Source: Author's Computation.

Table-4: Results of Growth Accounting without Intangible Capital and with Human Capital for Selected Countries during 1995-2019.

Country	CL(%)	CK(%)	CH(%)	TC(%)	TFPG(%)(D)	% point Difference of TFPG from table 3and 4
Austria	0.422858	1.620476	-0.09271	1.950627	-1.11E-01	9.87E-03
Belgium	0.625281	1.30007	-0.05342	1.871931	8.07E-03	5.22E-02
Bulgaria	0.512841	0.452542	2.376554	3.341937	-1.00E+00	1.19E+00
Czech Rep	-0.08117	0.808151	1.808085	2.535061	1.15E-01	-3.34E-02
Denmark	0.383288	0.699319	0.31243	1.395037	2.65E-01	-5.32E-02
Estonia	0.082273	1.701872	1.614717	3.398863	8.81E-01	-4.21E-01
France	1.00018	0.795776	-0.06885	1.72711	-8.71E-02	2.55E-02
Germany	0.344023	1.002077	0.092473	1.438572	-3.86E-02	3.92E-03
Greece	0.210638	0.312943	0.318899	0.84248	4.25E-02	-5.48E-01
Hungary	0.074907	1.077551	1.317554	2.470012	1.60E-01	-3.21E-01
Italy	0.379896	0.235785	-0.1055	0.510184	1.04E-01	-1.05E-01
Japan	-0.0285	0.744798	0.019993	0.736289	6.87E-02	1.87E-01
Luxembourg	6.486307	-1.4553	-1.60975	3.421249	-5.12E-02	-5.10E-02
Netherlands	1.270423	1.463537	-0.52833	2.205626	-1.86E-01	1.24E-01
Poland	0.043362	1.485677	2.044488	3.573527	5.36E-01	-6.39E-01
Portugal	-0.2928	0.563922	0.366368	0.637492	7.93E-01	-8.09E-01
Romania	1.355529	0.210286	2.955748	4.521563	-1.30E+00	9.04E-01
Slovenia	-0.05802	0.627475	1.262996	1.83245	9.28E-01	-8.35E-01
Spain	1.485472	0.925726	-0.33757	2.073632	9.64E-02	-6.64E-02
Sweden	-0.19342	1.297583	1.248455	2.352619	1.47E-01	-2.25E-01
UK	0.782328	1.079553	0.212348	2.074229	5.77E-03	6.76E-03
USA	0.110402	1.831351	0.505578	2.447332	2.27E-02	-1.45E-02

Source: Author's Computation.

Part B

Here we report the user cost share weighted growth accounting results in table 5,6,7 and 8 corresponding to our phase wise dropping and inclusion of our four factor inputs. Interestingly, in this case we find improvement in the results of the contributions of the factors to the GDP growth . From the table 5 we find contributions of intangible capital are positive across the countries in varying degrees though with smaller proportions while that of capital are also found to be positive with higher values in all countries and that of labour are also found to be positive in all countries excepting the four. The values of the contribution of the human capital are positive in the countries excepting the two Japan and Greece but the proportional contributions are much lower. Paralally, the contribution of tfp growth to GDP growth are also highly positive as compared to our previous results excepting for two countries. Now if we drop human capital and consider labour, capital and intangible capital then we find that the contribution of tfp to GDP growth becomes negative in most of the countries excepting very few while that of intangible capital remaining positive with its positive in almost all countries with the decrease in its contribution to GDP growth. Conversely, the contribution of capital and labour improves in most of the countries. Therefore, we can say that human capital produces direct impact on the efficient utilization of factors apart from its own contribution. Again if we drop both human and intangible capital (table-7) then also we find substantial improvement in the contributions of labour and capital to the GDP growth of the countries. We also find increase in the values of contributions of TFP to GDP growth in almost all the countries such that the % point differences of TFPGs between table-6 and 7 becomes negative for almost all the countries there by indicating overestimation of the contribution of TFP when we ignore the intangible capital in the MFP. Almost similar results hold if the

growth accounting results in table-8 where the inclusion of human capital along with K and L in MFP indicates the increase in the share of contributions of labour and capital in most of the countries coupled with fall in that of labour in few countries. Interestingly, the differences in TFPGs between table 8 and 7 are found to be negative for 13 countries implying the overestimation of TFPG in absence of human capital . On the whole we find that the ignoring intangible assets has led to overestimation of the role of TFP to the growth of GDP and human capital also has played a critical role in promoting the growth contribution of labour, tangible and intangible capital apart from its own contribution to the over all growth of GDPs of the countries. The growth accounting results using different weights (i.e. production elasticity and factor cost share weight) are found to be highly compatible with minor differences in the magnitudes in the values of contribution.

Table 5 : Cost Share Weighted Growth Accounting of Selected Countries with Intangible Capital and Human Capital (1995-2019)

Country	GGDP(%)	CL(%)	CK(%)	CI(%)	CH(%)	TC(%)	TFPG(%)
Austria	1.831161	0.319522	0.710116	0.169431	0.007442	1.206511	0.62465
Belgium	1.88273	0.56408	0.581383	0.057455	0.008299	1.211218	0.671513
Bulgaria	2.356854	0.256583	0.397704	0.076563	0.009053	0.739902	1.616952
Czech Rep	2.657986	0.072342	1.016508	0.091411	0.014403	1.194664	1.463321
Denmark	1.650924	0.230731	0.441122	0.17229	0.008919	0.853062	0.797863
Estonia	4.280042	-0.03012	1.883032	0.210482	0.003095	2.066326	2.213716
France	1.657126	0.307659	0.227439	0.089944	0.005754	0.630795	1.026331
Germany	1.416583	0.15526	0.369813	0.081707	0.004483	0.611263	0.80532
Greece	0.898134	0.19532	0.512865	0.03683	-0.00318	0.74184	0.156294
Hungary	2.638052	0.114344	0.518508	0.171559	0.019005	0.823416	1.814636
Italy	0.624616	0.149067	0.452882	0.049857	0.000505	0.652311	-0.0277
Japan	0.818446	-0.22874	0.428058	0.018462	-0.0003	0.217487	0.600959
Luxembourg	3.371614	1.000631	2.398446	0.055725	0.051346	3.506148	-0.13453
Netherlands	2.02837	0.547763	0.595742	0.108782	0.070979	1.323265	0.705105
Poland	4.098011	0.229066	1.192688	0.158496	0.016474	1.596724	2.501287
Portugal	1.45238	-0.11557	0.261538	0.078885	-0.00296	0.221895	1.230485
Romania	3.236308	-0.66448	0.912984	0.083616	0.010347	0.342462	2.893847
Slovenia	2.760818	0.203093	0.320291	0.049222	0.002993	0.575599	2.185219
Spain	2.168612	0.902114	0.967307	0.125684	0.005296	2.000401	0.168211
Sweden	2.496086	0.319014	0.985932	0.125668	0.014059	1.444673	1.051413
UK	2.08518	0.455381	0.670733	0.094356	0.005712	1.226181	0.858999
USA	2.495302	0.483556	0.744733	0.085654	0.002811	1.316754	1.178548

Source: Author's Computation.

Table 6 : Cost Share Weighted Growth Accounting of Selected Countries with Intangible Capital and without Human Capital (1995-2019)

Country	CL(%)	CK(%)	CI(%)	TC(%)	TFPG(%)	% point difference point between TFPG of table 5and 6
Austria	0.332429	0.739411	0.021375	1.093215	0.737947	-0.1133
Belgium	0.573627	0.591902	0.017508	1.183037	0.699694	-0.02818
Bulgaria	0.181178	0.415511	0.017904	0.614592	1.742261	-0.12531
Czech Rep	0.074223	1.045306	0.016888	1.136417	1.521569	-0.05825
Denmark	0.243029	0.465123	0.016546	0.724698	0.926226	-0.12836
Estonia	0.278179	1.910368	0.018781	2.207328	2.072715	0.141001
France	0.32029	0.236773	0.009249	0.566312	1.090814	-0.06448
Germany	0.171125	0.379775	0.006414	0.557314	0.859269	-0.05395
Greece	0.200023	0.524528	-1.5E-05	0.724536	0.173598	-0.0173
Hungary	0.11614	0.534575	0.047413	0.698127	1.939924	-0.12529
Italy	0.152847	0.466131	0.003016	0.621994	0.002621	-0.03032
Japan	-0.23355	0.437036	0.002877	0.206367	0.61208	-0.01112
Luxembourg	1.019763	2.443967	0.058122	3.521852	-0.15024	0.015704
Netherlands	0.139335	1.226476	0.030792	1.494338	0.534031	0.171073
Poland	-0.11872	0.270357	0.006843	0.158478	3.939533	-1.43825
Portugal	-0.74832	0.98435	0.007062	0.243094	1.209286	0.021199
Romania	0.210597	0.332736	0.007835	0.551168	2.68514	0.208706
Slovenia	0.210597	0.332736	0.007835	0.551168	2.20965	-0.02443
Spain	0.926739	0.994452	0.016309	1.937501	0.231111	-0.0629
Sweden	0.333093	1.029906	0.014068	1.377067	1.119019	-0.06761
UK	0.471157	0.692201	0.008872	1.172229	0.912951	-0.05395
USA	0.498831	0.768248	0.004009	1.271089	1.224213	-0.04567

Source: Author's Computation.

Table 7 : Cost Share Weighted Growth Accounting of Selected Countries without Intangible Capital Human Capital (1995-2019)

Country	CL(%)	CK(%)	TC(%)	TFPG(%) (C)	% point difference between TFPG of table 6 and 7
Austria	0.334108	0.743128	1.077235	0.753926	-0.015979308
Belgium	0.577106	0.595153	1.172258	0.635163	0.064530954
Bulgaria	0.262354	0.410453	0.672807	2.774257	-1.031995891
Czech Rep	0.075547	1.049747	1.125294	1.532691	-0.01112245
Denmark	0.243999	0.46738	0.711379	0.939545	-0.013318875
Estonia	-0.03596	1.94543	1.909474	1.812924	0.259790977
France	0.321449	0.237557	0.559006	1.09812	-0.007306193
Germany	0.171869	0.3806	0.55247	0.864113	-0.004844299
Greece	0.199904	0.525114	0.725019	0.173115	0.000482795
Hungary	0.116469	0.540032	0.656501	1.981551	-0.04162678
Italy	0.15297	0.467066	0.620036	-0.0204	0.023026273
Japan	-0.23381	0.438539	0.204731	0.613365	-0.001285393
Luxembourg	1.037336	2.480942	3.518278	-0.14285	-0.007392026
Netherlands	0.587576	0.636915	1.224491	0.803879	-0.269847203
Poland	0.238833	1.233324	1.472157	2.332773	1.606759648
Portugal	-0.11869	0.270697	0.152006	0.607938	0.601347919
Romania	-0.74947	0.988151	0.238684	3.904932	-1.219792258
Slovenia	0.21064	0.333853	0.544494	1.86195	0.347699673
Spain	0.93101	0.997836	1.928846	0.239766	-0.008654611
Sweden	0.421021	1.079673	1.500693	1.015187	0.103832412
UK	0.472877	0.694354	1.167231	0.917949	-0.00499832
USA	0.499556	0.76927	1.268826	1.226476	-0.002262896

Source: Author's Computation.

Table 8 : Cost Share Weighted Growth Accounting of Selected Countries with Human Capital and without Intangible Capital (1995-2019)

Country	GGDP	CL(%)	CK(%)	CH(%)	TC(%)	TFPG(%)	% point difference between TFPG of table 8 and 7
Austria	1.831161	0.298376	0.717042	0.05788	1.073298	0.757863	0.003937
Belgium	1.88273	0.590146	0.580067	0.026991	1.197204	0.685526	0.050363
Bulgaria	2.356854	0.260884	0.398552	0.085397	0.744833	1.612021	-1.16224
Czech Rep	2.657986	0.069508	1.018341	0.078483	1.166331	1.491655	-0.04104
Denmark	1.650924	0.229492	0.42066	0.097416	0.747569	0.903355	-0.03619
Estonia	4.280042	-0.03063	1.885809	0.103642	1.958822	2.32122	0.508296
France	1.657126	0.287976	0.232262	0.058386	0.578624	1.078502	-0.01962
Germany	1.416583	0.155945	0.370607	0.05165	0.578202	0.838381	-0.02573
Greece	0.898134	0.238295	0.510907	0.009221	0.758422	0.139712	-0.0334
Hungary	2.638052	0.105027	0.522344	0.077081	0.704452	1.9336	-0.04795
Italy	0.624616	0.155825	0.472115	0.012141	0.640081	-0.01547	0.00493
Japan	0.818446	-0.20996	0.428847	-0.0037	0.215184	0.603262	-0.0101
Luxembourg	3.371614	1.018203	2.435421	0.04388	3.497504	-0.12589	0.01696
Netherlands	2.02837	0.515441	0.608804	0.064906	1.189151	0.839219	0.03534
Poland	4.098011	0.230828	1.199536	0.083962	1.514327	2.583684	0.250911
Portugal	1.45238	-0.11554	0.261877	-0.02474	0.121598	1.330782	0.722844
Romania	3.236308	-0.66543	0.916586	0.065809	0.316968	2.91934	-0.98559
Slovenia	2.760818	0.129921	0.33061	0.055094	0.515625	2.245193	0.383243
Spain	2.168612	0.899581	0.965749	0.025888	1.891217	0.277395	0.037629
Sweden	2.496086	0.40328	1.033787	0.121171	1.558239	0.937847	-0.07734
UK	2.08518	0.444145	0.674974	0.059769	1.178888	0.906292	-0.01166
USA	2.495302	0.483447	0.749381	0.065577	1.298405	1.196897	-0.02958

Source: Author's Computation.

Section VII : Cross-Country Growth Accounting Results

The results of our cross country growth accounting done through the DPM with GMM are given in tables 9 below.. It is evident from the estimated results that the cross country growth accounting results are compatible with our country specific growth accounting results especially if we consider the role of intangible capital.. We find that the elasticities of the growth contributions of the explanatory factors labor, physical capital, intangible capital and human capital are highly statistically significant with their desired positive signs. This indicates that the cross country and cross time variations of growth contributions of these factors play statistically and economically significant role in the dynamics of variations of the cross country and cross time per capita GDP growth over the period through their production elasticities. It is further established that the elasticity of growth contribution of human capital is highest (0.2662%) which is followed by that of labor (0.2283%) , physical capital (0.1391) and intangible capital (0.0199%) respectively. The highly statistically significant value of the Wald Chi-square along with their very high P-value indicates correct specifications of the model with its robustness of estimation. Further the Chi-square value of the Sargan test along with their P-value also clearly indicate the overall validity of the instruments in analyzing the sample analog of the moment conditions used in our estimation process. To see whether the dynamics of the growth process of the countries explained by the growth contributions of the four factors reveal a converging tendency towards their steady state we have run a dynamic panel regression taking

initial log per capita real GDP as an argument in the MFP, the result of which are give in the table -10. The positive coefficient of the variable Log y_0 reveals the diverging tendency of the countries towards their steady state growth path with the coefficient being statistically highly significant. This seems to be due to the cross-country variations in the use of the level of intangible capital. On the whole we conclude that the results of our cross country growth accounting are highly compatible with the results of our country specific growth accounting such that the growth contributions of the intangible capital, human capital and physical capital along with that of labour are of crucial importance in sustaining the cross country and country specific growth of the countries of our panel.

Table-10: Dynamic Panel Results

Dependent Variable : dlngdpppe		
Independent variables	Coefficient	p-value
dlngdpppe L1	.0009019	0.552
dlnpck	0.1391203	0.000
dlnpch	0.2662458	0.000
dlnpci	0.0199044	0.000
dlnpcl	0.2283777	0.000
Wald chi2(5) = 199.00 Prob > chi2 = 0.0000 Sargan test of overidentifying restrictions chi2(269) = 464.3284 Prob > chi2 = 0.0000		

Source : Authors' Computation, gdpppe =GDP per persons employed

Table-11: Test of Convergence

Dependent Variable : dlngdpppe		
Independent variables	Coefficient	p-value
dlngdpppe L1	.1325373	0.001
lnY0	.0007399	0.000
dlnpck	.1435281	0.000
dlnpch	.2532329	0.000
dlnpci	.0155677	0.205
dlnpcl	.2559361	0.000
Wald chi2(6) = 473.26 Prob > chi2 = 0.0000		

Source : Authors' Computation

VIII: Conclusion :

We conclude this paper as follows. This study is concerned with the determination of relative roles of intangible ,tangible and human capital and also of TFP on the growth of real GDP for a set of EU countries and JAPAN and USA . We estimate the share weighted growth contributions of intangible, tangible, human capital and that of total factor productivity to the growth of real GDP by undertaking country specific growth accounting analysis . We use both the production elasticities of factor inputs and also the user cost of factor services as share weights for computing the share weighted growth contributions of factors in separate growth accounting analysis .We use neo classical well behaved MFP function to this end .We also undertakes the cross country growth accounting analysis.
We find that the intensity of the use of intangible capital as compared to that of tangibles has increased sharply over the period in a good number of countries. Further the average relative intensities of intangible capital corresponding to that of tangible capital are found to be high in Japan, USA, Sweden, UK, Denmark, Romania, France followed by the other countries. Therefore it can be viewed that capital deepening across the countries has taken place largely in terms of intangible capital.

Further we find that the inclusion of intangible capital and the human capital reduces the relative contributions of tangible capital, labor and TFP to the growth of GDP of the countries in varying degrees. It is also found that simultaneous inclusion of human and intangible capital in MFP has weakened not only the contribution of tangible capital and labour but also that of TFP. This clearly indicates that ignoring the intangible assets we actually over state the TFP growth or multifactor productivity growth as well as the growth contributions of tangible

capital and labour. So we can say that human capital produces direct impact on the efficient utilization of factors apart from its own contribution. When we use the user cost of factor services as weights and compute the share weighted growth contributions of the factor we find a bit improvement on the results of growth contributions. However the growth accounting results using different weights (i.e. production elasticity and factor cost share weights) are found to be highly compatible with minor differences in the magnitudes in the values of contributions.Our dynamic panel regression results also confirm the statistically and economically significant roles of the three capitals in the cross country variations in the growth of real GDP across the countries. We find diverging tendency in growth across our sample countries.

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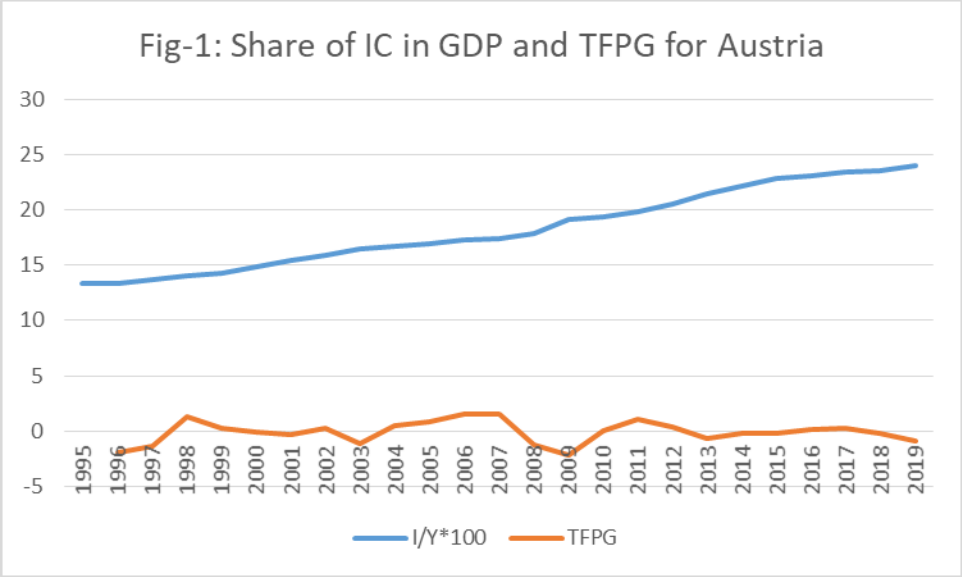
Appendix table-I: List of the Countries

Serial Number	Country
1	Austria
2	Belgium
3	Bulgaria
4	Czech Rep
5	Denmark
6	Estonia
7	France
8	Germany
9	Greece
10	Hungary
11	Italy
12	Japan
13	Luxembourg
14	Netherlands
15	Poland
16	Portugal
17	Romania
18	Slovenia
19	Spain
20	Sweden
21	UK
22	USA

Appendix II: Trends in share of Intangible capital in GDP and TFP growth



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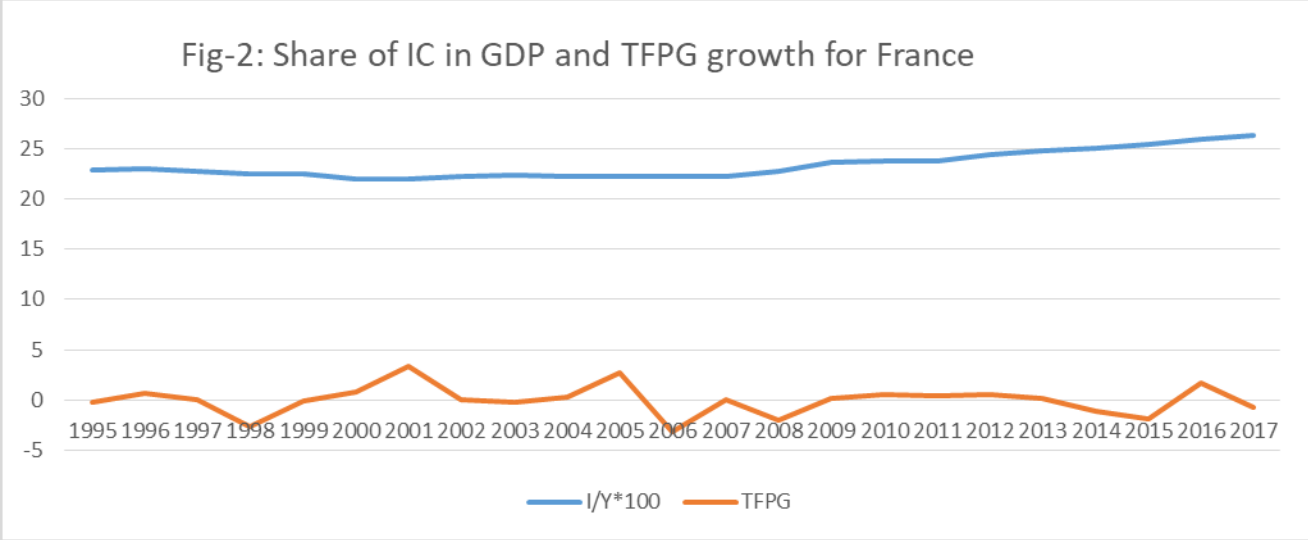

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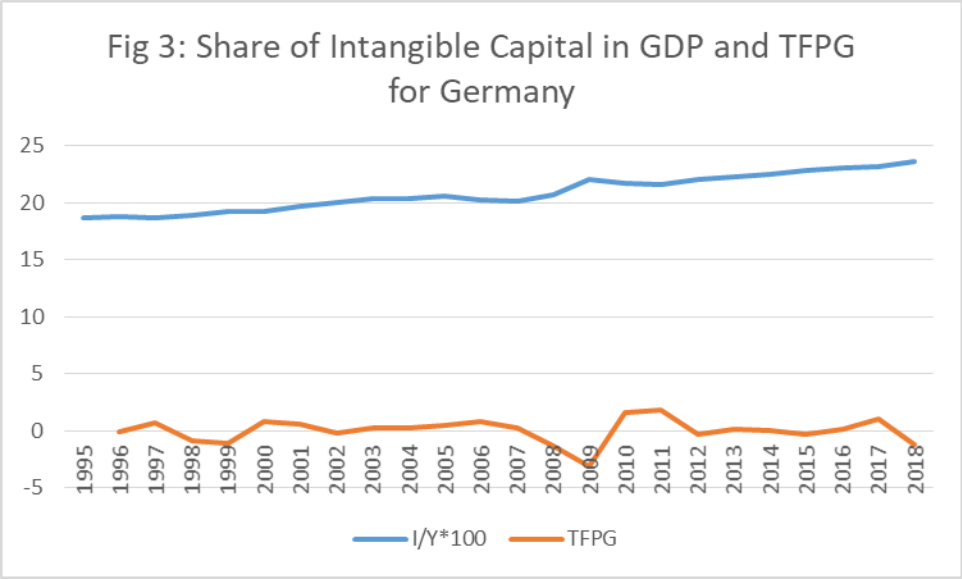

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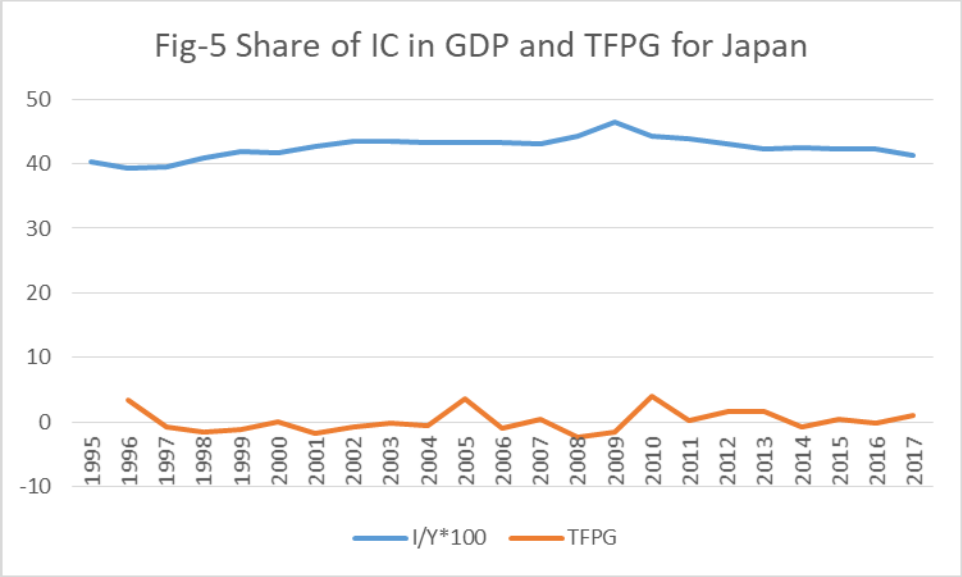

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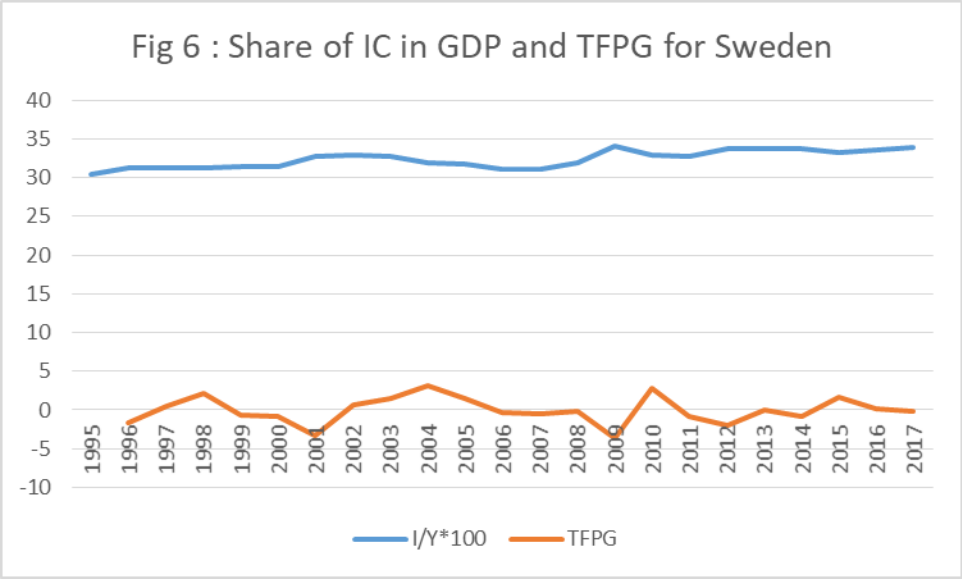

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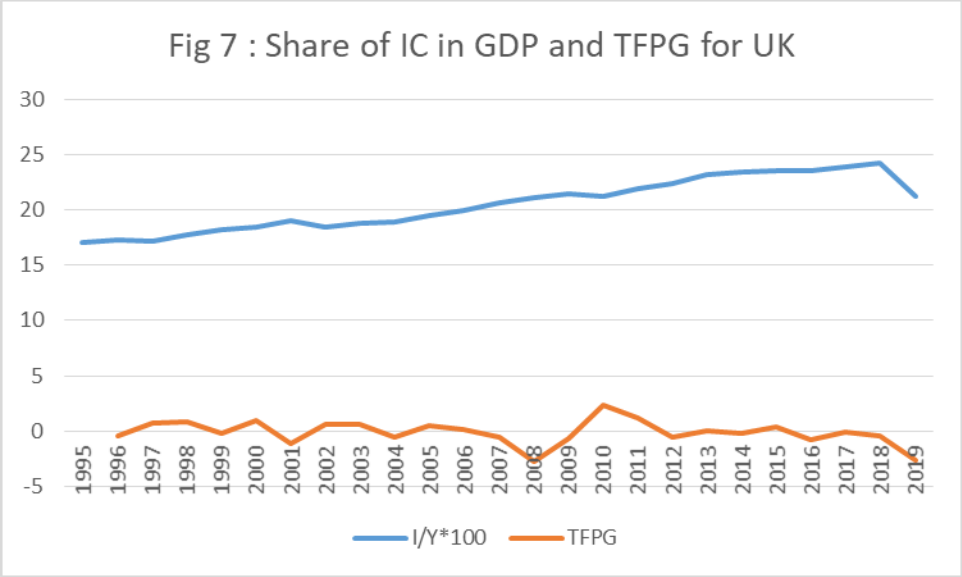

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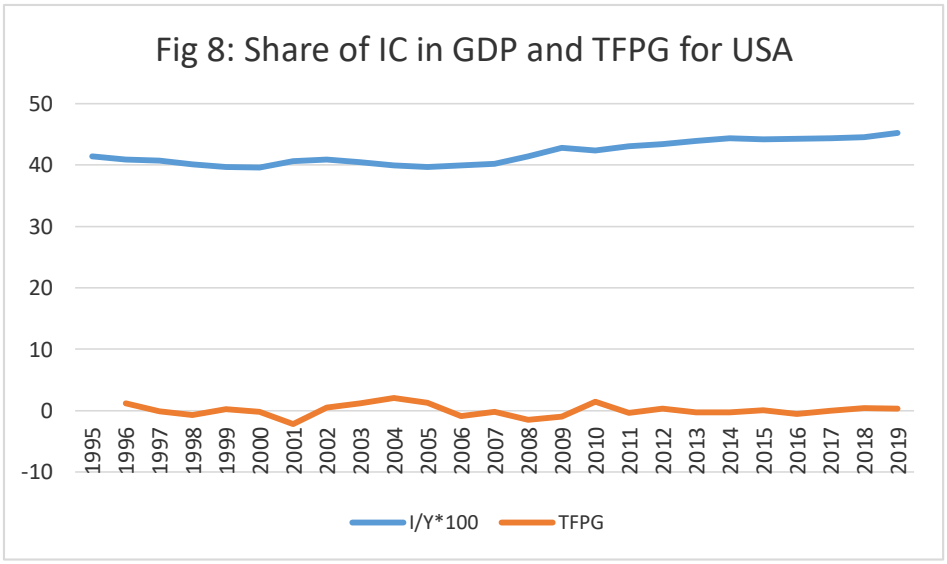

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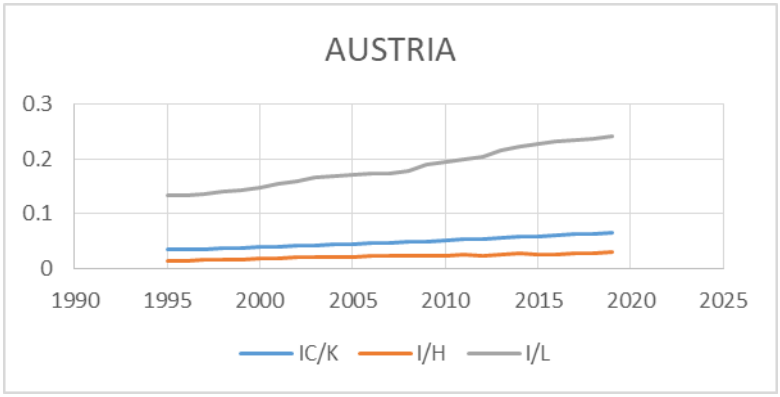
Appendix A : Trends in intensity of use of intangible capital per unit of Labour, Tangible and Human Capital (1995-2019)



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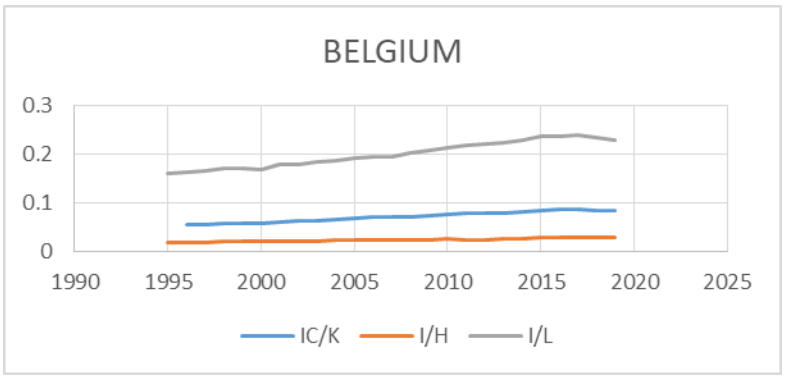

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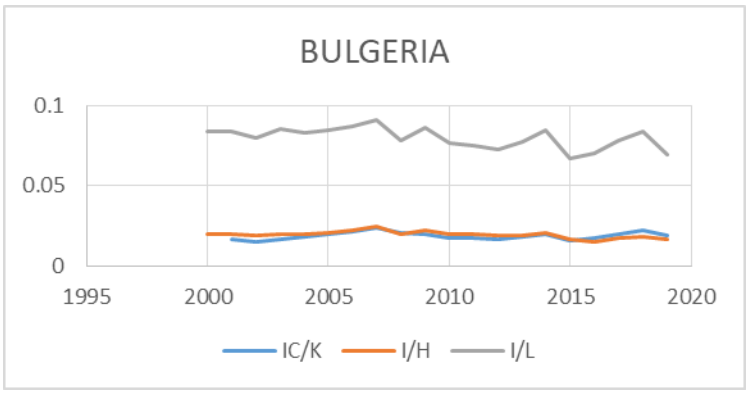

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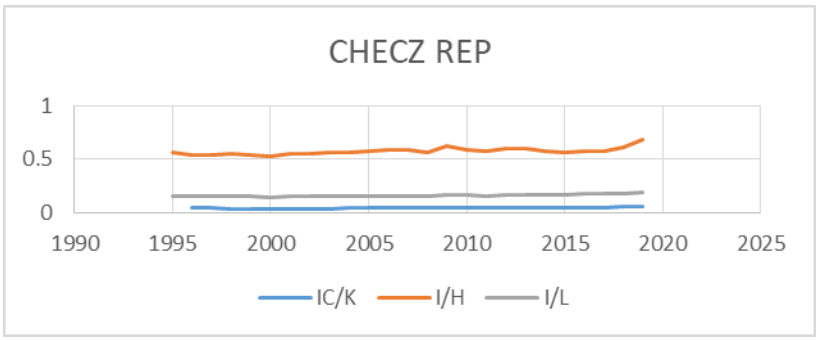

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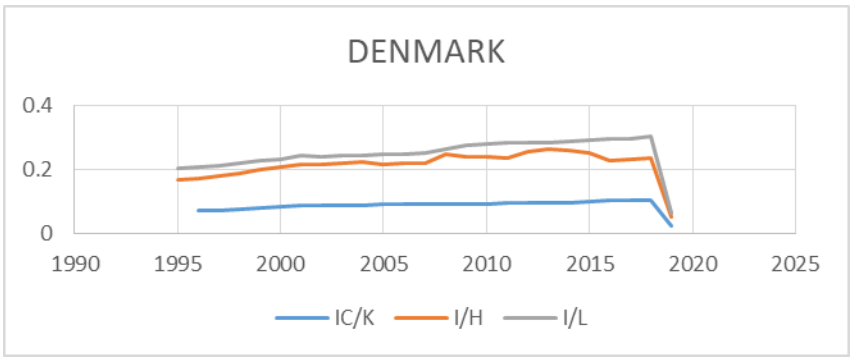

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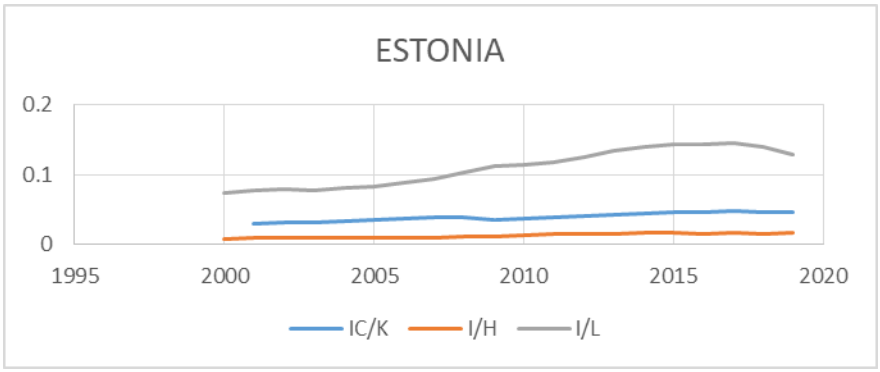

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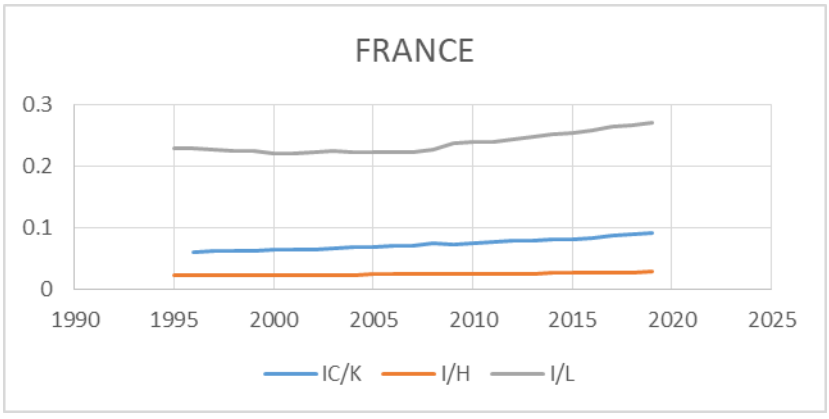

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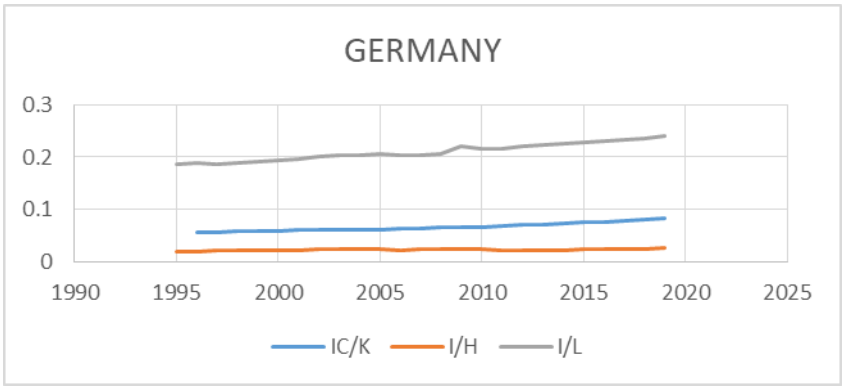

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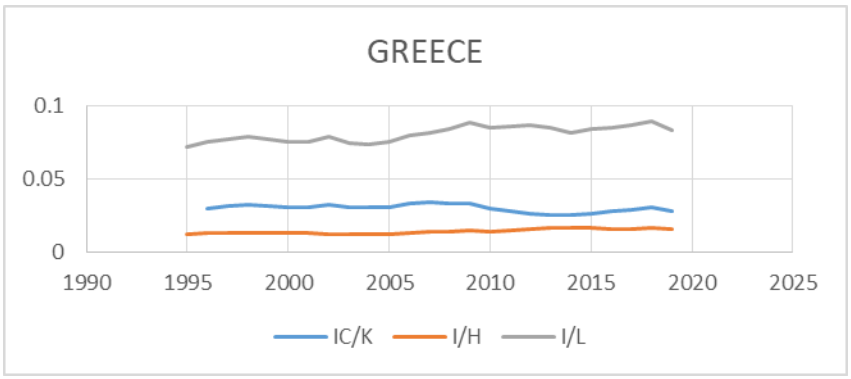

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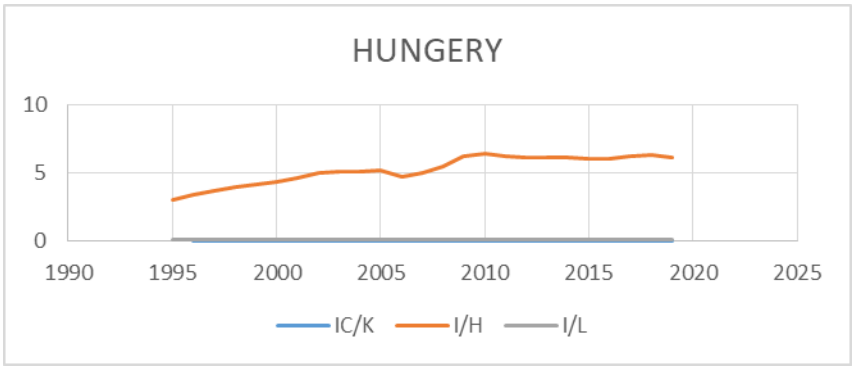

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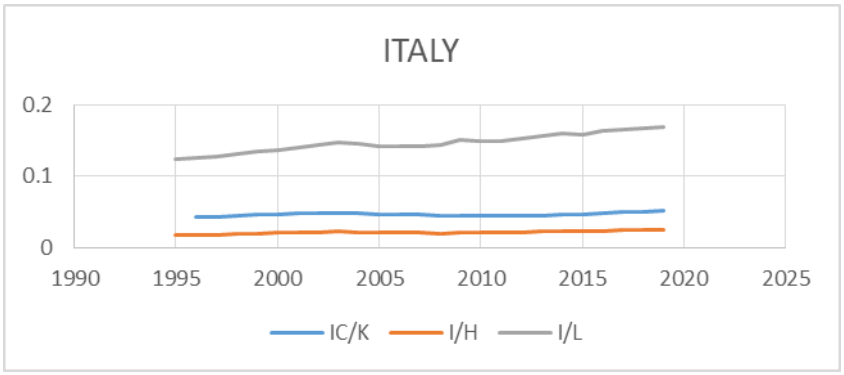

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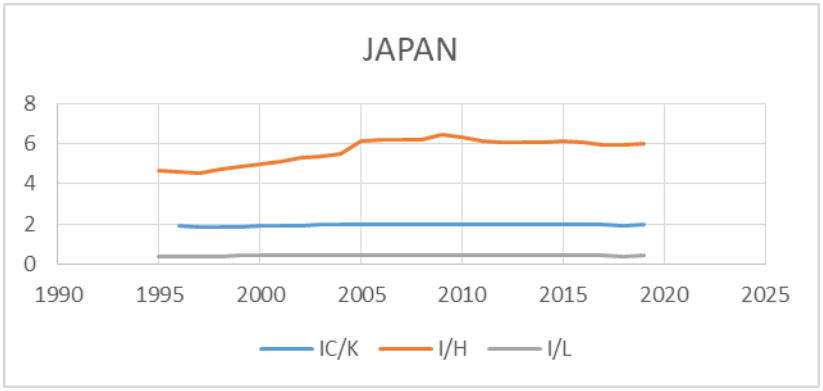

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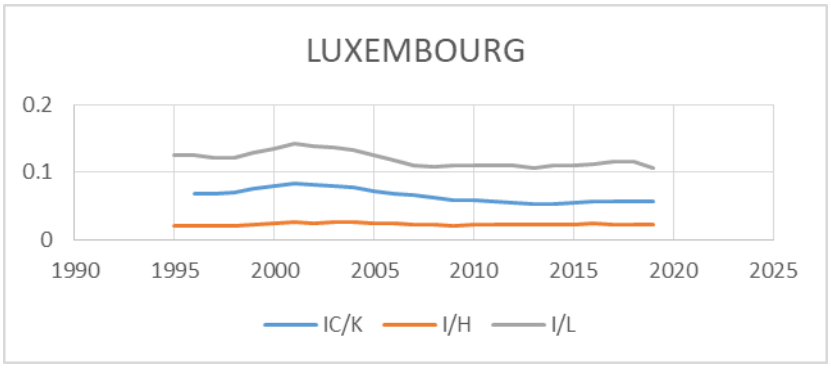

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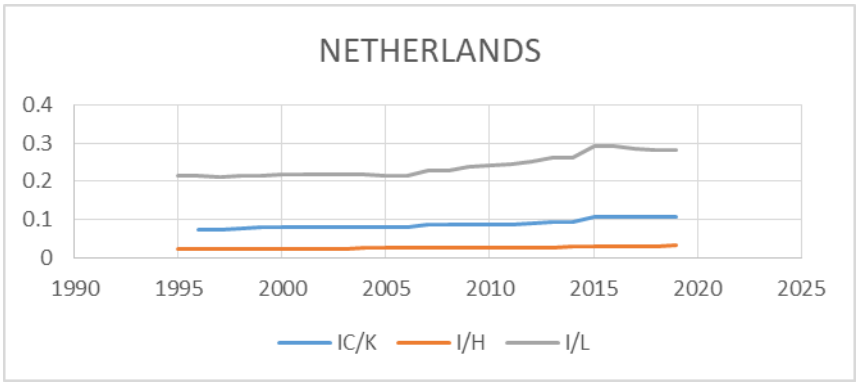

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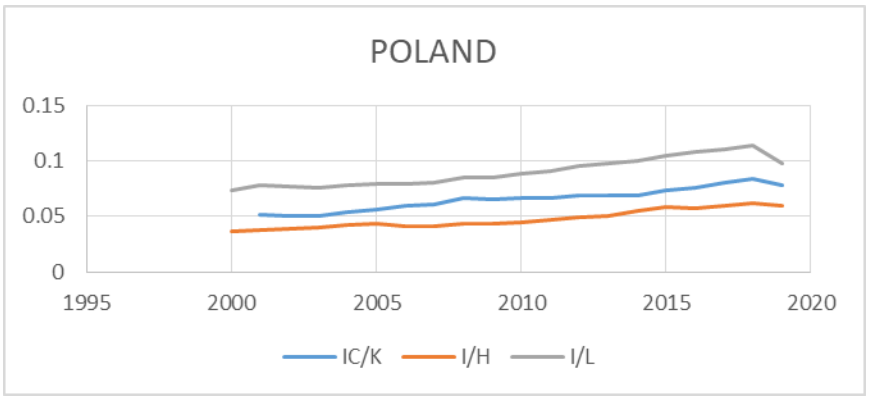

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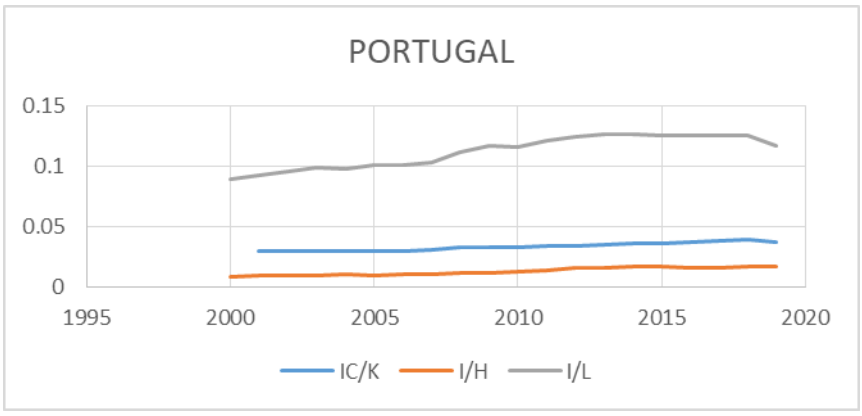

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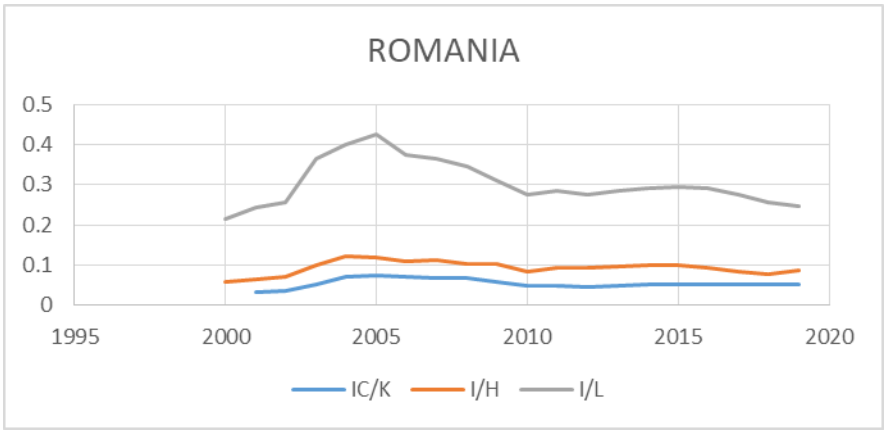

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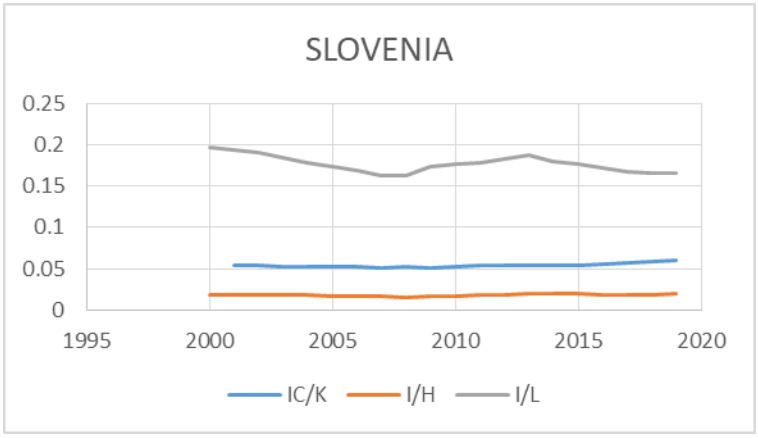

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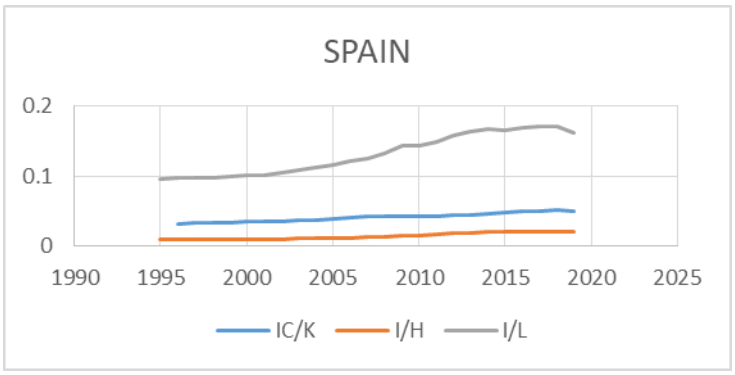

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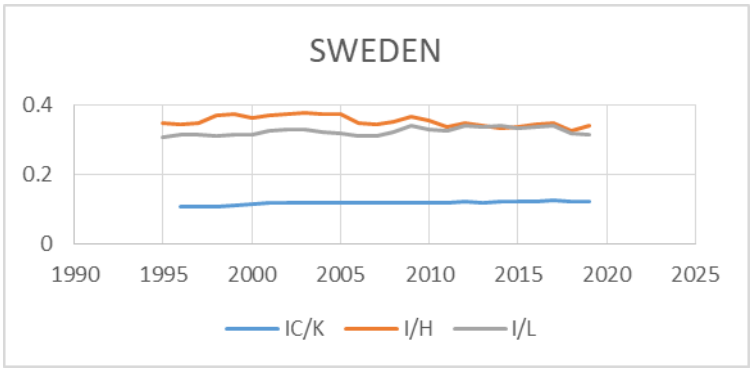

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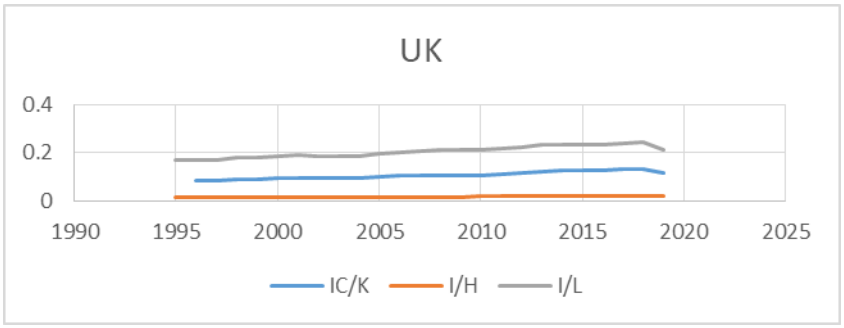

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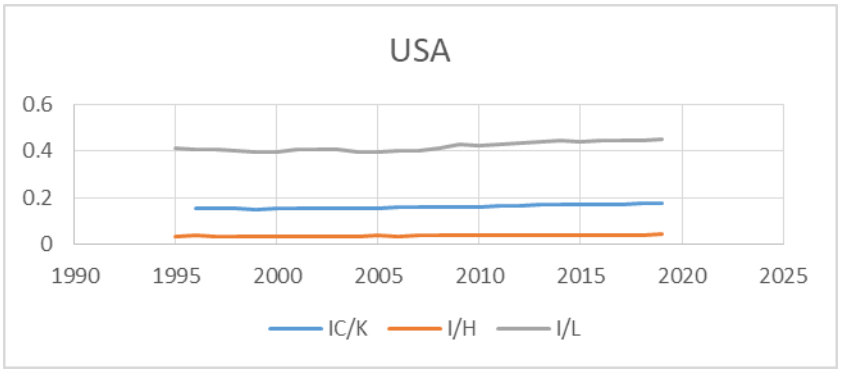

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