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Dynamics of Cross Country Variations in the Productivity Growth and the Role of Natural Capital (1995-2018)

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ABSTRACT

This paper estimates the country specific growth contributions of conventional factor inputs labor and capital along with that of natural and human capital by using multi factor production function analysis and determines productivity growth so as to highlight the relative impacts of natural and human capital on productivity growth using Solow residual method for the two sets of developed and developing countries. It also makes cross-country growth accounting to estimate the relative growth contributions of four factor inputs to growth for the same two panels of countries by using dynamic panel regression technique with GMM.

The relative growth contributions of factor inputs reveal varies in varying degrees across the developed countries with positive contributions of physical capita in all countries coupled with that of labour, and human capital in majority of the countries and negative negligible contribution for eight countries. The estimation of growth contributions for the set of developing countries also reveal varying results with all the countries experiencing positive contributions of capital coupled with positive contributions of human capital and natural capital in most cases and negative contribution of labour in some countries.

The differences in the estimated values of the total factor productivity growth (tfpg) with and without natural capital indicate upward bias in its estimation in most of the countries and downward bias in some other countries in our panel of developed countries. The same picture is found to persist when we drop human capital from MFP and take differences in the average tfpg estimated with four factors and that without human capital. This has happened in the growth accounting results of the developing countries panel also. However for the developing countries majority of countries have positive growth contributions of natural capital. Thus we conclude that the natural capital and human capital are the crucial factors for sustaining growth, the physical capital and labor apart albeit the growth contribution of labor are found to be small positive in most of the developed countries and small negative values for majority of the developing countries. The exclusion of natural capital and human capital from the conventional estimates of tfpg of the countries results an upward bias in its estimated values. Our cross-country growth accounting following dynamic panel regression gives robust results such that the elasticities of growth contribution of labour, capital and human capital in developed countries and that of capital, human capital and natural capital in developing countries are found to be economically and statistically highly significant with developed countries showing converging tendency while the developing countries reveal the diverging tendency towards their steady states. Our cross-country growth accounting results are almost compatible with the results of country specific growth accounting.

Key Words: Country Specific Growth Accounting; Productivity Growth; Developed and Developing Countries; Cross-Country Growth Accounting; Dynamic Panel Regression.

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1. Introduction

The empirical growth accounting exercise through the use of multi factor production function (MFP) has been a most common area of interest on the part of the economists and social scientists following the neo-classical tradition since the publication of Solow model of growth(1956) and thereafter the augmented Solow model of growth of Mankiw, Romer and Weil(1992) .A lot of country specific studies and studies on the cross country differentials in the growth rates and its convergence as well as on the estimation of productivity growth (i.e. the total factor productivity growth (TFPG)) across the countries using the MFP functions in this tradition have occupied a major part of the empirical growth economics literature (Barro, 1999; Barro and Martin,1994,2004;Benhabib and Spiegel,1994;Stiglitz,2001;Corrado , Hulten and Sichel,2009;Ruth and Thum,2013;Temple,1999; Aghion and Howitt, 2010;Ghosal,2007,2016; Islam, 1995…). Alongside we also find a lot of studies on the empirical exercises on the cross country variations of growth rates and the TFPG through the use of MFP by following the endogenous growth and the Schumpeterian growth traditions (Aghion and Howitt, 2010).

In fact the inquisitiveness on the part of the the academicians, researchers belonging to social sciences especially the economic science on the finding out sources of economic growth, productivity growth and the problem of catch –up in the present era of liberalization of trade, investment and finance has really been growing. The use of MFP analysis for accounting the contribution of various factors to growth with the use of cross country regression , panel regression techniques and the use of Solow residuals as a measure of productivity growth are almost common in growth economics literature . Surprisingly it is often found that the use the conventional MFP analysis mostly considers the factors Labor, physical capital, human capital, and technology as the only contributing factors to the growth of GDP of the countries. But this has led to the generation of tremendous bias in the estimation of cross country and country specific estimates of growth contributions of these factors and also the estimates of TFPG because of the exclusion of other most important factors. Later since the beginning of the present century , interest has been switched over to incorporate the intangible capital as an argument in MFP(Ruth and Thum,2013; Corradoet.al.,2009;McGrattan,2020;Baier,Dwyer and Robert,2006). However the most crucial and quintessential factor playing a major role to the generation of income of every economy i.e the natural resource and environment as an input factor are still generally ignored in the MFP used in these studies nevertheless the rental income generated through the depletion of the natural capital such as minerals , fossil fuels is incorporated in the value of GDP and in profit. It is unquestionable that the flow of income from the exploitation of natural resources can finance the higher levels of public and private consumption and also help improving the standard of living of the deprived segments of the society. Further the extraction of natural resources supports investment in physical and human capital through the use of resource rents and the taxes reaped from the on exploitation of resources. Consequently the exclusion of these vital factors as an argument in the MFP would obviously generate bias in the estimation of the growth rates and the TFPG of the countries.

Incidentally , another tradition which has come into vogue since last decade of the current century is to recognize role of the natural capital as a contributing source of the growth of GDP as well as that of TFP of the countries and so several studies , theoretical as well as empirical, have come onto the surface which take into consideration of the natural capital as an argument in the MFP along with the conventional factors and thereby attempt has been made to estimate the contribution of the natural capital to the growth of GDP and TFPG of the countries(Brandt , Schreyer,and Zipperer 2013,2017; Solow, 1974;Sandanato and Willebald, 2018,Stiglitz,2001; Withagen and Smuldres, 2012;Smulders et.al 2014). Unfortunately, in most of the studies only the non-renewable or exhaustible natural capital , (i.e. the sub-soil resources like fossil fuel, minerals, natural gas , oil etc) has been taken into consideration in the MFP and growth accounting exercises have been done at the country specific level as well as at the cross country level. It is undeniable that in the estimation of the contribution of natural capital to growth and TFPG remains incomplete and creates a bias if we do not incorporate the role of renewable natural resources like forest, water, soil/ land , mangrove etc. Incidentally ,a massive amount of studies have been done to assess the changes in the sectoral total factor productivity and technical as well as environmental efficiency specially in case of agriculture by considering natural factors through the use of frontier analysis and DEA technique (Linh ,Truc, LEE et. al.,2019;Anik et. al.,2017; Coelli and Rao,2005, Coelli et. al.,2007; Alessandra coli,2021,Chaudhary,2016 etc.). Furthermore it is well known that the production of goods and services creates negative externalities like pollution as a by-product which is also likely cause growth drag. So the non-adjustment of the growth of output and productivity with the environmental cost will obviously lead to the underestimation of the contribution of the factors to the growth and also to the TFPG. The study of Brandt et.al of 2014 has covered partially the pollution effect in terms of bad output through their empirical estimation of TFPG.

Moreover, while estimating the contribution of the natural capital on the growth of GDP and TFPG of the countries, none of the studies has considered human capital as a contributing factor so that there has still been an upward biasness in the estimation of the productivity growth. In fact, there are several ways by which the human capital can directly and also indirectly effect both the growth rates and TFPG . For instance it can affect the same by influencing directly the capacity of the country to innovate new technology suited to domestic production; by helping to catch-up the global frontier technological innovation in all kinds of production processes and resource use; by helping to adopt new technology instantaneously; by using modern technology embodied capital goods and also by ensuring the judicious use of the nature and the natural resources. Moreover it is true that modern age is the revolutionary age of knowledge capital ,ICT and AI, such that the human capital quintessentially plays a crucial role not only for the efficient use of resources and technologies but also through its direct contribution to the productivity growth of the nations. Further a crucial problem with the growth accounting has been that technological progress often become embodied in new capital goods due to qualitative improvement of capital goods such that it becomes difficult to separate the influence of capital accumulation from that of innovation .It may so happen that some kinds of capital goods require specific human resource embodied with high modern skill. 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. So the productivity measurement with only non-renewable natural capital and conventional factors but without considering the human capital is likely to provide an overestimation bias towards estimation of TFPG.

On the other hand , under the era of globalization when there is free cross border movement of capital, technology, and goods and services, the growth accounting exercise and estimation TFPG of the countries will reveal biasness in the estimation of the role of factors , if the contribution of the external sector to domestic production of the nations is ignored. Surprisingly we hardly find any study on growth accounting and TFPG using the MFP where the labour(L) , physical capital(K), intangible capital (Kin) human capital(H), non-renewable natural capital(Nnr) , renewable natural capital(Nr) and the contribution of external sector (E) are simultaneously considered as arguments in the MFP . Therefore the main quest of this paper centers round the following questions. First, how could the contribution of the total natural resource (viz; renewable and nonrenewable) to the economic growth and the TFPG of the economy be captured explicitly and correctly without having any bias in estimation? Second, how does the role natural capital in terms of its contribution to economic growth and TFPG really varies across the developed and developing countries over time? Is there any possibility of convergence in growth if we consider both the natural and human capital in the MFP? Third, how do the contributions of other factors get affected if we include the natural capital in MFP? How are the TFPG and the growth contributions of other factor inputs affected in the presence of human capital in the MFP as an argument?

Under this backdrop this paper undertakes country specific growth accounting exercises to determine the contributions of the renewable and non-renewable natural capital together and the other factor inputs viz; labour, physical and human capital to the country specific growth and TFPG for the period 1995-2018 for two panels of countries: one for developed and the other for the developing countries **(Appendix table V)**. We have also done cross country growth accounting exercise for the same two sets of countries. We use MFP function for the country specific estimation of TFPG and the growth contribution of factor inputs: labour, physical capital, natural capital and human capital. For cross country growth accounting we use dynamic panel exercise with GMM technique. Unlike other studies, we proceed to estimate the role of natural capital on the growth rates and also on TFPG in three ways. First we take MFP for growth accounting and measure country specific TFPG within the Solow residual framework such that real GDP (Y) of the economy is produced out of labor (L) , physical capital (K), the human capital(H) and the natural capital with its both components renewable and non-renewable (N). Then we exclude natural capital as argument from the MFP ceteris paribus and estimate the country specific growth and TFPG .We use the country specific least square regression technique and determine the production elasticities of the factor inputs initially by considering all the four factors and then by dropping the natural capital argument ceteris paribus and finally by dropping human capital, keeping the other three inputs in the MFP. Then by multiplying the production elasticities of the respective factor inputs with their year to year rates of changes or growth rates we have the share weighted growth contribution of each factor for each year over the period under consideration and then by subtracting the sum total of the growth contributions of the factors from the year to year growth rates of real GDP we find the TFPG for individual year with and without natural capital and also without human capital for our two sets of sample countries. To find out the country specific average growth contributions of factors and the TFPG we take arithmetic averages of the contribution of factors and TFPGs. Therefore the differences between the values of the rates of growth rates of real GDP and TFPGs with natural capital and without natural capital signify the role of the natural capital in the growth and TFPG of the respective countries.

Finally, for the simultaneous estimation of role of natural capital along with that of other factors of inputs at the cross country growth accounting we use translog functional form of production function based on Cobb-Douglas technology and apply Dynamic Panel Method(DPM) with GMM technique.

This paper is structured as follows. Section -II briefly reviews the literature in this area; Section –III explains the specification of the models and methodologies to be used and the data base; Section -IV will present the results of the growth accounting exercises for the panel of developed countries and compare the productivity growth for different cases; Section - V presents the results of the growth accounting exercises for the panel of developing countries and compare the productivity growth for different cases ; Section – VI analyses the cross country and cross time growth accounting results of the dynamic panel regression and finally the section-VII gives the concluding observations of this study.

II. BRIEF RVIEW OF LITERATURE

There is wide range of theoretical and empirical literature on the growth accounting exercise done through the use of aggregate MFP both at the country specific level and also at the cross country level since the publication of the Solow model of growth (1956). The empirical exercises at the cross country level gathered momentum immediately after the publication of augmented Solow model of growth empirics by Mankiw, Romer and Weil containing the cross country analysis (1992). Later the empirical literature on growth economics has been flooded by varieties of empirical studies on cross country differentials of growth and TFPGS and the rate of convergences by using MFP containing conventional factor inputs such as labour , sometimes labour measured in efficiency units, physical capital, technology and later by incorporating human capital, intangible capital along with physical capital (Barro, 1999; Barro and Martin,1994,2004;Benhabib and Spiegel,1994;Stiglitz,2001;Corrado , Hulten and Sichel,2009;Ruth and Thum,2013;Temple ,1999; Aghion and Howitt, 2010;Ghosal,2007,2016; Ruth and Thum, 2013; Corrado et.al,2009; McGrattan,2020; Baier, Dwyer and Robert,2002). A varied and at the same time controversial results have been reported towards the explanation of the trajectories behind the within country as well as cross country growth and TFPG differentials along with rates of convergence or divergence. Incidentally there has been a lot of micro level studies such as industry specific studies on the productivity analysis and the efficiency of the use of resources/ factors through the use of frontier analysis and DEA analysis both at the country specific level and also at the cross country level via the use of country specific NIC classification of industries (Linh ,Truc, LE et. al.,2019;Anik et. al.,2017; Coelli and Rao,2005, Coelli et. al.,2007; Alessandra coli,2021,Chaudhary,2016 etc.). The results reported so far are found to be anonymous and sometimes controversial also thereby leading to the proliferation of further such research works.

It seems that the exclusion of natural resources as arguments in the MFP has been acted as a major source of controversy regarding the relative contributions of the factors to the output growth and TFPG. Recently several attempts have been made to estimate the stock of natural resources by the Word Bank Expert Group, OECD and other country specific agencies. A lot of individual researchers have also estimated the series of stock of natural resources at the country specific level (Sandanato and Willebald, 2018.). Using these data base there are studies on the measurement of the contribution of natural capital on productivity growth of the countries(Brandt , Schreyer,and Zipperer 2013,2017; Sandanato and Willebald, 2018, Stiglitz,2001; Brock and Taylor, 2005;Withagen and Smuldres, 2012;Smulders et.al 2014). A detail empirical analysis based on OECD productivity data base has been done for OECD countries by Brandt et.al (2013,2017) which shows how the bias arises in the traditional measure of TFP using only labor and capital as factor inputs due to the non-inclusion of factor services of natural capital, albeit of nonrenewable natural capital only . They have also shown the process of adjustment which could be made to the traditional measure of TFP in terms of a component measuring the difference between the rates of changes in the stock of physical and natural capital weighted by the ratio of the cost share of natural capital to the

GDP of the countries plus the change of MFP without natural capital. Interestingly in their studies the service contribution of each factor such as labor, capital and renewable natural capital is estimated by multiplying the rate of change in the factor inputs weighted by their user cost shares to total input cost of production of output of the economy. Therefore the user cost ratio times the rates of change in the stock (in case of physical capital) and flow of the factors gives the growth contribution of each factor. All these studies have incorporated the non-renewable natural capital as factor input in the MFP along with conventional inputs labor and capital. Obviously the non –inclusion of intangible capital, human capital, renewable natural capital and the environmental pollution which is the by-product of production of goods and services renders biasness in the estimation of the TFPG measured as difference between the change or growth of output and the sum of the user cost share weighted growth contribution of factor inputs labour, capital and non-renewable natural capital to output growth. Uptil now there is hardly any study on growth accounting and TFPG using the MFP containing labour(L) , physical capital(K), human capital(H), non-renewable and renewable natural capital(N) as arguments in the MFP . So our study will bridge up these gaps in the literature on the relative contribution of both types of natural capital such as renewable and nonrenewable, human capital to country specific productivity growth and the growth rates of GDP and their cross country differentials through the country specific and cross country growth accounting exercises. We also examine whether the inclusion of conventional factor inputs along with the natural capital and human capital in growth accounting leads to converging tendency of the productivity growth across the two panels of countries.

III. Model Specification, Methodology and the Data Base.

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 capital(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 GDP and the sum of the growth contributions of all the factor inputs through the use of the MFP. In other words the TFPG is measured in terms of the Solow Residual. As we have mentioned that the measurement TFPG without the inclusion of natural capital both the renewable and non-renewable produces upward bias in the estimation of the TFPG of the countries. Moreover since the production of GDP of an economy produces negative environmental externalities i.e pollution which affects human health labor productivity, productivity of human capital, the estimation of TFPG without taking into account of the environmental impact will again produce the bias in the estimation of not only the TFPG but also the growth contribution of factors like labor and human capital. To estimate the role of natural 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 natural capital containing both renewable and non-renewable natural resources and also the human capital as arguments ,along with the labor and physical capital in the MFP .

We know that the underlying idea behind the growth accounting indicates that the growth of aggregate output (say GDP) of an economy is the result of the growth of inputs utilized in production or the result of the increase in efficiency in the use of inputs due to technical change i.e. through the upwards shift of production function. Robert Solow (1957) established this idea in his empirical work in accounting for the post war U.S. economy's growth showing that most of the growth was due to increase in efficiency in input utilization (i.e. because of TFP growth). He has identified firmly that growth decomposition follows from the theory of production i.e from some clear economic assumptions regarding the production functions. Viz. i) a stable and smooth functional relationship between inputs and outputs at the economy wide aggregation level ii) inputs are paid according to their marginal product iii) constant returns to scale and iv) The Hicks neutral technical change i.e. MRS function remain unchanged (or ratio of MP remain unchanged for given K/L) and finally, perfect competition exists in both factor and product market such that the price of output equals marginal cost and factor prices equals their MP which is nothing but their user costs or shadow prices and finally the production function satisfies Inada conditions. This unknown or exogenous factor effecting the growth of GDP of an economy is the TFPG or the Solow Residual which is a measure of our ignorance. But there may be a lot of other factors, physical capital & labour apart viz the improvement of human capital which may be a determinant of growth (Jorgeson and Grilliches, 1967). Moreover, the stock of natural capital with its two components (viz. renewable and non-renewable) may also plausibly be a determinant of unexplained growth which is usually attributed to technological progress in most of the studies by ignoring the role of the same. So the contribution of change in technology on the growth of output of any economy must be estimated in an unbiased way as the exclusion of major factors from production function may lead to the biased estimation of growth contribution of factor inputs including the TFPG. In fact while estimating the TFPG, the real output and the real factor inputs must be accounted for properly. If 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. Actually there are two methods of doing the growth accounting exercises for determining the growth contribution of the factor inputs to the growth of total output : first one is the computation of the production elasticities of the factor inputs and then use the same to compute the share weighted growth contribution of factors and second one is the estimation of the ratio of the user cost of factor services to the total factor cost and use the same to find out the share weighted growth contributions of the factor inputs to the growth of total output . In both cases the sum of the weights be equal to unity. We have used both the methods.

Therefore, we proceed to estimate the contribution of unknown TFPG along with growth contribution of other factor inputs. 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}):

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

Here i = 1 .... 16 for developed country panel

i = 1 .... 14 for country panel

t = time period 1995 2018

Where Y = Real GDP (at 2015 constant US$ PPP)

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

K = Stock of physical capital (expressed at 2018 constant US$ PPP)

N = Stock of natural capital including its two components (renewable and non-renewable) (at constant 2018 US$ PPP)

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: $Y = A_t K_t^{\beta k} L^{\beta L} H_t^{\beta h} N_t^{\beta n}$ ....(2) Taking logarithmic transformation of the production function, the relationship for long term growth can be expressed as

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

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 dependant variable) on the log of the real values of factor inputs.

So the country specific regression equation becomes

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

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 i.e. $\sum^4_{J=1}\beta\ (\Delta X_j\ /\ X_j)$, 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 average growth contribution of the factors and TFPG for each country over the period. This exercise is done thrice by following the same method, one with ‘N’ 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 natural 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 ‘N’ as argument in the production function so that we have the TFPG contribution to growth of real GDP for each country without natural capital. Then we compare the TFPG with ‘N’ as argument in production technology and TFPG without ‘N’ as argument, so that we may have a distinct or explict insight about the role of ‘N’ 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. Finally we do the same 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. These three growth accounting exercises are done for each of the countries of the two panels. These 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 two panels 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 natural 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 output of the economy. The results are reported and analyzed in **Appendix-A.**

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 natural 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, N, in per capita 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:

$(\log y_t - \log y_{t-1}) = (\log A_t - \log A_{t-1}) + \beta_l (\log l_t - \log l_{t-1}) + \beta_k (\log k_t - \log k_{t-1}) + \beta_h (\log h_t - \log h_{t-1}) + \beta_n (\log n_t - \log n_{t-1}) + (\log €_t - \log €_{t-1})$……..(5)

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…..,16 (for developed countries) and i=1,2,3,4,…..,14 for developing countries

t= 1,2,………………T (year) i.e. from 1995 to 2018; .

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 natural 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

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

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

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, world development indicator data base , World bank Data base and from the Changing Wealth of Nations 2021 data base of World Bank ranging from 1995 to 2018. We also take the aid of the OECD Productivity data base. The 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. The total labor hours employed in the production of GDP of an economy for each year are given in the Penn world table 10.0 version. On the other hand the data on the stock of physical capital or the produced capital, the human capital and the natural capital are taken from the World Bank's Changing Wealth of Nations data base 2021.The Changing Wealth of Nations 2021 gives us a comprehensive updated data base and analysis of the World's wealth accounts of 146 countries with time series data from 1995 to 2018 such that the estimates of wealth are in market exchange rates using PPP.

In our study the produced capital / capital consists of manufactured or built assets such as machinery, equipment and physical structure and also the value of built up urban land which is valued as a mark-up on other produced assets. The valuation of the stock produced capital is done by using the perpetual inventory method. The capital stock data are expressed at constant

2018 US dollars at market exchange rates by using the Penn World Table 9.1 version's asset specific investment deflators for bringing the data in real terms .The urban land of the countries is valued as a fixed proportion of the value of physical capital such that a constant proportion equals 24 per cent is assumed to be applicable to all countries and therefore the value of urban land is estimated as 24 per cent of produced capital stock of the countries in a particular year.

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 give 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.

On the other hand the non-renewable natural capital in our study consists of fossil fuel energy viz oil, natural gas and coal and ten metals and minerals viz; bauxite, copper, gold, iron ore, lead, nickel, phosphate rock, silver,tin and zinc.The value of a nation's stock of non-renewable resource is measured as the present value of the stream of expected rent that may be extracted from the resource until it is exhausted, i.e. over its life period. However the present value of rents from the fossil fuel energy and mineral resources is estimated by assuming that the rents remain constant in future years. On the other hand the renewable natural capital in our study , the data on which are taken from the Changing Wealth of Nation , consists of forests (timber and ecosystem service), mangroves, fisheries, agricultural land (cropland and pasture land) and protected areas. Usually the total value of asset should be equal to the discounted sum of the return or the net benefits generated from the asset during its life period. In the case of natural capital net benefits are the resource rents i.e, the total value of production (or revenue) less the total cost of production. In World Bank Group estimate of countries' wealth the present value of renewable and non-renewable natural capital is estimated by applying a common discount rate of 4% for all the resources and all years, such that the life time of renewable natural capital or resources is capped to 100 years . For non-renewable natural capital however, the life time is estimated directly on the basis of reserve and the extraction path / rate of extraction.. The resource rents are smoothed as a lagged five years average for avoiding the year to year price fluctuations. It is worth mentioning that the country specific GDP deflator is used for all natural resource components for expressing the nominal values t at constant 2018 US dollars at market exchange rates.

Section -IV: Results of the Growth Accounting Exercises for the Panel of Developed Countries.

Since the growth rates of GDP as well as productivity depends to a greater extent on the relative positions of the countries in respect of their productive base and its growth, before analyzing the results of the growth accounting of the individual country we examine the average resource base of the countries and its variations over time which are given in the **Appendix table-I.** It is found from the table that out of the 16 countries in our panel of developed countries the resource endowment of average stock of natural capital are highest in Denmark followed by Switzerland, Australia, France, Germany, UK, Norway, Spain, USA. The cross-time variability of the stock of natural resource of the developed countries measured in terms of standard Deviations(SDs) are found to be higher in France, Germany, Japan, Sweden, Switzerland, USA. So it is expected that the differences in the cross-time variation in productive base of stock of natural capital will affect not only the variations of the productivity growth (TFPG) but also the growth contributions of the physical capital and human capital. The average stocks of physical capital over time are also found to be highest in Italy followed by Canada, USA, Australia, UK, South Korea, and Netherlands. However, the cross-time variability in the physical capital are found to be highest in UK followed by Italy, Netherlands. In other countries of this panel the cross-time variability is not much higher. Of course it is likely that in the countries having higher average level of stock of physical capital and natural capital may experience lower TFPG with higher growth rate and growth contribution of capital. Now if we consider the average stock of human capital alongside we also find that Australia, Netherlands, South Korea, Sweden, Switzerland are mostly rich as compared to other countries in the panel. As a fall out, one may expect that these resource reach countries are likely to experience lower TFPG coupled with higher growth contribution of physical and human capital along with natural capital.

To judge this one has to have the insight about the average rates of growth real GDP and that of the stock of three capitals combined with the total labour hours which are give in **table -1** below

Table- 1**: Average Growth rates (%) of factor inputs and Output (1995-2018) of developed countries**

country	GDP	L	K	H	N
AUS	3.195536	1.52465	3.353851	3.254455	4.897202
AUT	1.850631	0.357203	1.74476	1.482484	0.676889
CAN	2.810588	1.264306	2.614643	2.126452	1.959826
DEN	1.632563	0.376205	1.238208	1.971032	0.534971
GER	1.426943	0.19981	1.173005	1.637978	1.308099
FRA	1.640292	0.556483	1.745543	1.501513	0.61845
ITA	0.617391	0.365273	1.318451	0.392809	0.147094
JAP	0.848431	-0.2429	1.08877	-0.1565	1.881336
NETHERLANDS	2.033646	0.959048	1.658749	1.899323	0.723516
NORWAY	2.051958	0.965125	2.365856	0.913645	2.968804
SPAIN	2.183098	1.805974	2.898349	1.102408	0.963504
SOUTH KOREA	4.375788	0.114945	5.054076	4.041736	1.721034
SWEDEN	2.518323	0.790169	1.082864	2.982768	1.790482
SWITZLERLAND	2.014936	0.65293	1.291868	1.655806	0.741631
UK	2.100296	0.874366	1.630568	2.03532	0.117094
USA	2.492866	0.76709	2.036774	2.195531	1.622767

Source: Author's Computation

We find that all the countries in this panel have experienced the varying rates of average growth of stock of physical, human and natural capital with highest positive growth rates are found to persist in Australia (physical capital 3.35%, human capital 3.25%, and natural capital (4.90%)) and this is also accompanied by higher rate of growth of GDP (3.20%). South Korea reveals highest growth rate in GDP (4.38%) followed by growth of Physical Capital (5.05%) and Human Capital (4.04%) coupled with relatively lower average growth in natural capital (1.72%). While Norway has achieved higher growth rates of physical capital and natural capital, the USA has experienced higher growth rates in Physical capital (3.04%) and Human capital (2.2%) followed by the lower average growth rate of natural capital (1.62%) during the period. Interestingly growth rate of labour hours are also higher in Australia, Canada, Spain followed by other countries. Obviously the difference between the relative rates of growth of the factor inputs will be reflected in the country specific average growth contributions of factors as well as on the TFPG depending on their respective production elasticities (β_j , j=row vector: 1….4).The results country specific production elasticities of the factor inputs determined through country-specific regression analysis by using MFP with natural capital and without natural capital are given in **Appendix table II.** It follows from the table that the country specific β_j vary substantially across countries with the production elasticities of labour are found to be negative in UK, Sweden and it is statistically insignificant in UK. For other countries namely Canada, Austria, Italy, Netherlands, Spain, South Korea etc. the β_L are found to be positive significant. Conversely, the production elasticities of natural capital are found to be negative for most of the countries excepting Austria, Italy, Japan, Norway, Spain, Canada and South Korea which have positive significant production elasticities of natural capital. However, the negative production elasticities in Australia, UK, USA, France, and Netherlands are found to be statistically significant. Surprisingly, the production elasticities of physical capital are found to be highly significant for all countries in this panel with the percent contributions significantly differing from zero. However, the production elasticities of human capital are found to be positive in most of the countries excepting Australia, Austria, Norway, Netherlands and Switzerland. The positive production elasticities of the other countries (Austria, Canada, France, Denmark, South Korea, Sweden, UK and US) are found to be statistically significant. The values of the adjusted R-squad are found to be highly significant ranging from 85.67% to 99.8% across the countries. We have also run country specific separate regression by including separate interactive term of physical capital and human capital (lnK and lnH) as an additional argument in the MFP in order to see the interactive effect of it on the production elasticity on physical capital (as the qualitatively improved stock of capital over time embodies frontier technologies which requires specific skilled human resource.). And we find that in all the cases the elasticity coefficient of the interactive term are positive and significant. We also find that the incorporation of the inter-active component as argument in MFP has weekend the coefficient of physical capital in most of the cases (βk).Therefore, it is plausible to say that the presence of strong inter-active effect of physical and human capital seems to have produced some impact not only on the growth of output but also on the TFPG especially for the countries Canada, Germany, Netherlands, UK. This seems to be due to the embodied nature of capital goods and so the TFPG for these countries have been found to be lower and even negative which will be discussed in the analysis of growth accounting **(Appendix table IIA)**. However, if we drop the natural capital from the MFP, regression result reveal the persistence of negative production elasticities of human capital in six countries which in most cases are found to be statistically significant. Further we find that there is an improvement in the production elasticities of physical capital in all the countries in varying degrees excepting Canada where it is found to be poor and statistically insignificant coefficient. We observe another change in the production elasticity of labour such that the elasticity coefficient is found to be negative in Norway, Sweden and Australia which are found to be statistically insignificant excepting that of Sweden. So, it is obvious that the relative growth contributions of the factors including natural capital will reveal some kind of differences in the same when we use MFP without natural capital.

The results of the growth accounting of our panel of developed countries are given in the **table 2,3 4and 4A.**

Table-2 : Results of Growth Accounting With Human Capital and Natural Capital for Developed Countries During 1995-2018.

Country	GGDP	Cl (%)	CK (%)	CH (%)	CN (%)	TC (%)	TFPG (%)
AUS	3.195536	0.059495	5.862544	-2.67543	-0.18391	3.062698	0.132838
AUT	1.850631	0.20013	2.015223	-0.3975	0.035302	1.853153	-0.00252
CAN	2.810588	1.524267	0.533711	0.618806	0.187777	2.864561	-0.05397
DEN	1.632563	0.248825	1.156646	0.264074	-0.00738	1.662162	-0.0296
GER	1.426943	0.109234	1.352142	0.035672	-0.06966	1.427389	-0.00045
FRA	1.640292	0.296574	0.705376	0.8457	-0.18417	1.663478	-0.02319
ITA	0.617391	0.326871	0.157679	0.068525	0.011657	0.564731	0.05266
JAP	0.848431	-0.10953	0.759033	-0.02624	0.312795	0.936052	-0.08762
NETHER	2.033646	0.667693	1.866098	-0.40428	-0.05582	2.073688	-0.04004
NOR	2.051958	0.013134	0.073866	-0.01315	0.305859	0.379704	1.672254
SPAIN	2.183098	0.944497	1.041189	-0.00356	0.168202	2.150329	0.032769
SOUTH KOREA	4.375788	0.056386	3.390616	0.702578	0.330107	4.479687	-0.1039
SWEDEN	2.518323	-0.63149	1.176842	1.831583	-0.04615	2.33079	0.187533
SWITZ	2.014936	0.229103	2.235614	-0.40516	-0.03178	2.027778	-0.01284
UK	2.100296	0.415854	1.235626	0.441344	0.005789	2.098613	0.001683
USA	2.492866	0.327935	1.825313	0.355026	-0.04834	2.459935	0.032931

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

If we look at the results given in **table-2** above we see that in most of the countries the average total growth contributions of all the factors together are positive ranging from 4.48% in South Korea to 0.37% in Norway. The productivity growth (TFPG) in Norway is found to be highest positive (1.67%) followed by Switzerland (0.19%) Australia (0.13%), Italy (0.05%), USA (0.03%), Spain (0.03%) and UK (0.002%) respectively. Surprisingly, the productivity growth of nine countries amongst the 16 countries is found to be very small negative. It is astonishing to note that in all countries excepting Norway the TFPG are found to be poor. If we look at the growth contributions of natural capital it is found to assume poor negative values even in the resource rich country Australia, Denmark, Germany Sweden etc. Surprisingly, the growth contribution of capital has been found to be positive across the countries in varying degrees with its highest contribution in Australia (5.86%) followed by South Korea (3.39%), Switzarland (2.23%), Austria (2.02%), Netherlands (1.87%), USA (1.82%), and UK (1.23%) Sweden (1.18%), Germany (1.35%), Demark (1.5%) rspectively. However, growth contribution of labour are found to be low in almost all the countries excepting Canada (1.52%) followed by Netherlands, Italy, UK, and USA and so on. Only two countries reveal poor negative growth contribution in this respect. The growth contributions of human capital in eight countries are found to be positive. Parallely if we consider the growth accounting results after the dropping of the variable natural capital but with the inclusion of human capital **(seeTable-3)** we find relatively smaller decline in the growth contribution of capital in almost all the countries excepting Canada where it becomes a very small negative (-0.21%). Interestingly, in Canada there is increase in growth contribution of labour (1.73%) and human capital (1.40%), TFPG remaining negative (0.02%). It is interesting to note that the values of TFPG i.e. productivity growth in this case are found to be very small negative in the countries Austria, Canada, Denmark and Japan. Now if we look at the differences between the TFPGs computed with the four factor inputs and the TFPGs computed without natural capital of the developed countries we find the negative values of the differences for 12 countries out of 16 countries. Therefore, it is quite obvious that there has been an upward bias (or over-estimation) of TFPG in absence of natural capital. Therefore, it is plausible to conclude that the absence of natural capital produce substantial impact on the overestimation of productivity growth of the countries estimated through the MFP containing the four factor inputs. Further, we can also say that natural capital plays an important role in the growth of output and in the reduction in the upward biasness in the estimation of TFPG of the countries.

Table-3: Results of Growth Accounting with Human Capital and without Natural Capital for Developed Countries during 1995-2018.

Country	Cl(%)	CK(%)	CH(%)	TC(%)	TFPG(%)	% Point DIFF*
AUS	-0.04239	5.581324	-2.52013	3.0188	0.176736	-0.0439
AUT	0.199042	2.002065	-0.32098	1.880126	-0.0295	0.026973
CAN	1.735101	-0.20805	1.407594	2.934647	-0.12406	0.070086
DEN	0.249411	1.099695	0.312607	1.661714	-0.02915	-0.00045
GER	0.131081	1.331713	-0.0679	1.394892	0.032051	-0.0325
FRA	0.533346	0.08361	0.905503	1.522459	0.117833	-0.14102
ITA	0.35074	0.181486	0.065494	0.597719	0.019672	0.032988
JAP	-0.14521	1.040562	0.009004	0.904354	-0.05592	-0.0317
NETHER	0.80824	1.566107	-0.34562	1.839075	0.194571	-0.23461
NOR	-0.03791	2.070409	-0.18691	1.791614	0.260344	1.41191
SPAIN	1.447422	0.846067	-0.22089	1.973539	0.209559	-0.17679
South KOREA	0.037536	3.690528	0.839776	4.119004	0.256784	-0.36068
SWEE	-0.62208	1.185674	1.763195	2.179707	0.338616	-0.15108
SWITZ	0.248366	2.168803	-0.36495	1.952115	0.062821	-0.07566
UK	0.558618	0.920061	0.579659	1.978247	0.122049	-0.12037
USA	0.390068	1.72231	0.348313	2.306591	0.186275	-0.15334

Source: Author's Computation. * difference of TFPGs between table 2 and 3

The negative contribution of the natural capital may seemingly be explained in terms of the fact that the resource rent as well as revenue from natural capital seems to have utilized for the improvement in the stock of physical capital and human capital in the resource rich countries (Capital and Human Capital). This is substantiated by our estimated growth contribution of capital in these countries (Australia, Canada, Austria, h Korea, UK, Switzerland, Netherlands) which are also found to have experienced higher average growth rates of real GDP. In fact with the depletion of the non-renewable natural stock of capital it is likely that the countries will try first to look for alternative source of energy as well as for increasing the productive base without natural capital i.e the physical capital and human capital. It has already been said that the inter-action of human capital and physical capital produces substantial impact on the production elasticities of the Capital and labour.

Table 4: Results of Growth Accounting with Natural Capital but without Human Capital for Developed Countries During 1995-2018.

Country	CL(%)	CK(%)	CN(%)	TC(%)	TFPG(%)	% Point DIFF *
AUS	0.582991	2.607844	-0.14069	3.050145	0.145391	-0.01255
AUT	0.204917	1.663998	-0.0129	1.856012	-0.00538	0.002859
CAN	1.458647	1.175709	0.227119	2.861475	-2.70152	2.64755
DEN	0.271481	1.383308	-0.01824	1.636547	-0.00398	-0.02562
GER	0.117409	1.370184	-0.0613	1.426292	0.000651	-0.0011
FRA	0.093277	1.70476	-0.19583	1.602205	0.038087	-0.06127
ITA	0.37599	0.245223	-0.00257	0.61864	-0.00125	0.053909
JAP	-0.13656	0.755557	0.275764	0.894757	-0.04633	-0.0413
NETH	0.635215	1.469553	-0.04488	2.059892	-0.02625	-0.0138
NOR	-0.00094	0.069236	0.334021	0.402317	1.649641	0.022613
SPAIN	0.974529	1.025412	0.16351	2.163451	0.019648	0.013121
South Korea	0.080131	4.084329	0.391057	4.555518	-0.17973	0.075831
Sweden	-0.76489	2.718413	0.377972	2.331499	0.186824	0.000709
SWITZ	0.161947	1.907698	-0.01408	2.055569	-0.04063	0.027791
UK	0.12038	1.984412	-0.0142	2.090596	0.0097	-0.00802
US	0.462417	2.03775	-0.04736	2.452807	0.040059	-0.00713

Source: Author’s Computation. * difference of TFPGs between table 2 and 4

Table 4A : Growth Accounting with Capital and Labour for developed Countries

Country	GGDP	Cl (%)	CK(%)	TC(%)	TFPG(%)	% point difference *
AUS	3.195536	0.480403	2.536259	3.016662	0.178874	-0.03348
AUT	1.850631	0.20615	1.640407	1.846557	0.004074	-0.00946
CAN	2.810588	1.668539	1.302105	2.970644	-0.16006	-2.54147
DEN	1.632563	0.272068	1.326934	1.599002	0.033561	-0.03754
GER	1.426943	0.114856	1.271849	1.386705	0.040238	-0.03959
FRA	1.640292	0.330817	1.116139	1.446956	0.193336	-0.15525
ITA	0.617391	0.379481	0.238085	0.617565	-0.00017	-0.00107
JAP	0.848431	-0.13591	1.055577	0.919671	-0.07124	0.024914
NETH	2.033646	0.755417	1.268926	2.024343	0.009303	-0.03555
NOR	2.051958	-0.18148	1.998803	1.817323	0.234635	1.415005
SPAIN	2.183098	1.04256	1.004263	2.046823	0.136275	-0.11663
S.Korea	4.375788	0.062664	4.619389	4.682053	-0.30627	0.126535
Sweeten	2.518323	-0.94436	3.326035	2.381674	0.136649	0.050175
SWITZ	2.014936	0.174102	1.891633	2.065735	-0.0508	0.010166
UK	2.100296	0.346174	1.620275	1.966449	0.133847	-0.12415
US	2.492866	0.520823	1.932857	2.453679	0.039187	0.000872

Source : Authors' computation * difference between table 4A and 4

Table 4A reports the results of growth accounting when we consider L and K in MFP. It is evident that for majority of the countries the contribution of TFPGs to growth are over estimated i.e. there is an upward bias in the estimation of role of TFP on growth and it is reflected by the negative values of differences of TFPGs between **table 4A** and **table 4**

Interestingly, if we look at our growth accounting results (**Table-4**) which are estimated by using the MFP without human capital but including physical capital , natural capital and labour we find that the growth contribution of capital have fallen in some countries like Australia (2.61%), Austria (1.66%), Canada (1.17%) , Switzerland (1.90) which are accompanied by rise in the growth contribution of capital in the countries like South Korea (4.08%), Sweden (2.71%), UK (1.98%), US (2.03%), Germany (1.37%), France (1.70%) respectively. Once again we find poor negative values of productivity growth for the countries Austria, Denmark, Italy, Japan, Netherlands, South Korea, and Switzerland with higher negative values of Canada (-2.70%). However, TFPG for Norway (1.65%) , Sweden (0.19%) and Australia (0.15%) are found to remain almost same as compared to the values of TFPG given in **table-2.** So, we can conclude that for the explicit unbiased estimation of the productivity growth of the countries and also to determine the explicit role of natural capital we need to consider both the human capital and natural capital as arguments in the MFP along with the physical capital and labour as the physical capital, renewable natural capital and human capital are accumulated over time along with higher qualities of physical capital which are likely to embody the frontier technology. Moreover, we have found the substantial impact of the interactive effect of human capital and physical capital on the production elasticity of physical capital as such and labour . Interestingly it is to be noted that the countries which have experienced boom in resource position or relative scarcity or downswing in the their resource position over time are likely to realize higher contributions of the factors the during the period of resource boom and the same may reveal low figures during the period of resource scarcity depending on the overall economic conditions of the countries as well as on the global economic situation. This seems to have happened in the resource rich countries in our sample. Obviously the growth of GDP as well as productivity growth has been affected accordingly.

Therefore, the average figures for growth contributions and TFPG give us a clear insight as compared to what is reflected in the year to year growth contributions of the factors and TFP. Moreover, another interesting explanations for the relatively poor positive and negative values of TFPG for the countries **(see Table-2 and 3)** may be the fact that when the factor inputs are accurately accounted for and there is the possible inclusion of all factors in MFP, the estimated values of productivity growth of TFPG is likely to be low or even negative.

Section -V: Results of the growth accounting exercises for developing countries

The summary statistics of the productive base for the period 1995-2018 containing labour, physical capital, natural capital and human capital of the developing countries are given in **appendix table-III**. It is clear that the average stock of natural capital is highest in China followed by Mexico, Argentina, Pakistan, Chili and South Africa, Egypt, India. The cross-time variations of the stock of natural capital measured by respective SDs are found to be highest in India followed by Brazil, Morocco, Pakistan such that the same for other countries are not found to be substantially larger. This seems to be due to the variations in the rate of extraction of sub-soil natural resource and the destructions of forest, mangroves, and fisheries with the varying but lower rate of replenishment of natural resource. As far as the stock human capital is concerned China occupies top position followed by Egypt, Mexico, and Indonesia. A varied picture of cross-time variability in the stock of human capital is found in **appendix table-III** where the higher values of SD are found in Morocco, Argentina, Chili, China, Bangladesh, Philippines. On the other hand, the stock of physical capital is found to be highest in China which is followed by South Africa, Philippines, Brazil, India, and Mexico. However, the degrees of cross time variability of the average stocks of physical capital are found to be highest in Indonesia, Morocco, Brazil and Egypt. The other countries experienced moderate variability in the average stock of physical capital over their mean values. Obviously, the use of labour force (measured in terms labour hours) and its variability depend on a lot of factors namely the macro-economic conditions of the economies which is reflected in terms of the real GDP and its growth and its variability, the application of the technology, the use of modern intangible capital which are basically the labour saving. So the variability in the factor inputs will to some extent produce differential impact on the growth rates of the factors vis-à-vis their impact on the relative growth contributions to the growth of real GDP which also directly affect the productivity growth that is measured in terms of Solow residuals. On the other hand the average growth rate of stock of capital **(Table-5)** is found to be highest in China (10.67%) followed by Bangladesh (7.81%), India (6.85%), Egypt (5.33%), Indonesia (5.45%). On the whole all the developing countries in our panel have experienced positive growth rates of the stock of physical capital in varying degrees along with their positive growth rates of output in varying degrees with highest rate of growth of GDP achieved by China (9.09%) and followed by India (6.61%), Bangladesh (5.82%) Philippines (5.1%) respectively. Other countries have achieved moderate rates of growth. Conversely rates of growth of the stock of natural capital of all the countries excepting Nigeria are found to be positive with highest growth rate in Morocco (4.82%) which is followed by India (3.92%), China (3.64%), Brazil (3.61%) coupled with moderate rates of growth for other countries. However, Countries like Nigeria, China and India, Bangladesh have achieved a very high rate of growth of human capital over the period which read the figure 9.05%, 7.98%, 5.87%, and 5.12% respectively. The other countries in the panel have achieved moderate rates of growth. Surprisingly, the growth rates of labour hour in Nigeria and Brazil are found to be negative along with their moderate rates of growth of physical capital. While in Morocco average growth rate of use of labour hours is found to be highest over the period (6.23%) in India it is 1.09% and in Pakistan and Philippines these are 2.90% and 2.20% respectively. So it is obvious that even in the developing countries rate of growth of capital and human capitals are not lower as compared to that of the developed countries. The possible explanations may be given in terms of the liberalization in trade, investment and finance as well as the competition across the countries to catch up the global productivity and technological frontier.

The country specific regression results derived from MFP including four factor inputs and excluding the natural capital and the coefficients of the production elasticities are given in **Appendix table –IV**. When we consider the MFP with four factor inputs the production elasticities of labour are found to be significantly negative in case of Morocco, Nigeria, South Africa, Indonesia while it is significantly positive in case of India, Mexico, Argentina, Brazil, Philippines. Interestingly, the production elasticities of physical capital are also found to be highly statistically positive significant for most of the developing countries in our panel excepting Nigeria, Pakistan, Mexico. However, the elasticity coefficients of human capital in Pakistan, Nigeria and that of labour in Mexico are highly positive and statistically significant. The same in almost all the countries excepting Mexico and South Africa are found to be highly positive in varying degrees and also statistically significant .However these are estimated to be negative in case of Mexico and South Africa. On the whole cross time variability of the four factors together explain 98 to 99 % of the cross-time variability in the growth of output. However, the dropping of natural capital from the production function brings about major change in the production elasticities of labour, keeping a minor change in human capital and physical capital. And this seems to be the result of the inter-active impact of physical and human capital as we have stated in section –IV.

Table 5: Average Growth rates (%) of factor inputs and Output in Developing Countries (1995-2018)

Country	GGDP	L (%)	K (%)	H(%)	N(%)
Argentina	2.424761	1.447117	2.800772	4.498285	1.451428
Bang	5.818022	0.215978	7.805463	5.118947	2.461284
Brazil	2.328769	-0.38295	2.498362	1.798423	3.606739
China	9.087099	0.24546	10.66509	7.978198	3.641773
Egypt	4.53816	2.157016	5.632528	4.019135	2.688714
Indo	4.364301	2.140946	5.453178	3.702855	2.677877
India	6.610778	1.094213	6.845073	5.873862	3.917788
Chili	4.004791	1.16515	5.712222	4.59378	3.3009
Mexico	2.748438	2.025084	2.907076	2.702245	0.045165
Morocco	4.308046	6.230506	4.605227	3.562733	4.816873
Nigeria	5.27559	-0.73629	2.656799	9.053267	-1.19307
Pakistan	4.177548	2.913518	2.937543	4.293853	1.477325
Philippines	5.096205	2.207913	3.884104	3.704874	1.542082
SA	2.718561	1.446161	2.347232	2.538492	1.522875

Source: Author's Computation.

The results of our growth accounting with natural capital and human capital, as well as without natural capital but with human capital and also with natural capital but without human capital are given in **table-6,7,8 and 8A.**

It is evident that the average productivity growth rates of seven countries out of the fourteen are found to be negative albeit with their smaller values. Interestingly, in the leading countries with higher growth rates of GDP viz; China and India the estimated productivity growth rates with natural capital are found to be negative. While the countries having positive TFPG reveal poor values of the same excepting the Country Nigeria for which it is 1.19%. However, the growth contribution of natural capital in Bangladesh, India, Morocco, Mexico, Pakistan are found to be negative while those for the countries Brazil, Indonesia, South Africa are 0.56%,0.44%, 0.37% respectively. On the other hand the growth contributions of human capital are found to be positive in all the countries excepting Mexico and South Africa with highest contribution in Nigeria (4.16%) which is followed by China (4.02%), Pakistan (2.63%), and India (1.80%) respectively. Surprisingly, in case of developing countries of our panel we also find high positive contributions of physical capital in all the countries with its highest value in Indonesia (5.51%), China (5.48%), South Africa (5.47%), India (5.14%), and Bangladesh (5.1%). Conversely, the growth contributions of labour in eight countries are found to be negative. While the same for the rest of the countries in the panel are found to be positive in varying degrees. But if we look at the growth accounting results without natural capital we find an interesting impact after dropping of natural capital

on contributions of capital, human capital and labour such that in some countries contributions of physical capital and human capital have been improved while the same for other countries have declined marginally in varying degrees **(see table-7)**. The dropping of natural capital has produced very little impact on the contributions of labour. Further, it also follows from table 6 and 7 that the differences between TFPG with and without natural capital are positive in eleven countries thereby reflecting the under estimation (downward bias) of the productivity growth due to non-inclusion of natural capital which are reflected in terms of the positive values of the percentage point differences though small are the values. However, we do not find any major changes in the productivity growth without natural capital. Now if we drop the human capital and take into account L, K and N in MFP then we find over estimation of TFPG in seven countries in absence of human capital relatively to what we have estimated by considering four factors together in the MFP and it is reflected by the negative values of the percentage point differences in TFPGs **(see Table-8).** All the estimated values of the growth contributions and the productivity growth given in table 6,7 and 8 clearly reveal that the absence of natural capital and sometimes both natural and human capital lead to the overestimation of productivity growth. So, we can plausibly conclude that the developing countries which are basically natural resource based countries need to develop both the human capital and physical capital in the presence of high rate of depletion of both the renewable and non-renewable natural resource for sustaining the growth process.

Table-6: Growth Accounting With Human Capital and Natural Capital for Developing Countries during 1995-2018.

Country	GGDP (%)	Cl (%)	CK (%)	CH (%)	CN (%)	TC (%)	TFPG (%)
Argentina	2.424761	1.357976	0.671288	0.448555	0.171976	2.649795	-0.22503
Bang	5.818022	-0.01669	5.10095	0.65554	-0.04306	5.696742	0.12128
Brazil	2.328769	-0.21143	0.643512	1.291299	0.556016	2.279398	0.049371
China	9.087099	-0.02252	5.485749	4.02735	0.336309	9.826892	-0.73979
Egypt	4.53816	0.206335	4.109522	0.145827	0.092718	4.554402	-0.01624
Indo	4.364301	-2.01154	5.514461	0.779235	0.442923	4.72508	-0.36078
India	6.610778	0.358834	5.138106	1.802308	-0.68222	6.617028	-0.00625
Chili	4.004791	-0.05162	3.578594	0.18187	0.241078	3.949925	0.054865
Mexico	2.748438	1.997544	0.733274	-0.03752	-0.00492	2.688375	0.060064
Morocco	4.308046	-0.05723	1.800416	2.800231	-0.36591	4.177512	0.130535
Nigeria	5.27559	-0.30432	0.173539	4.164343	0.053179	4.08674	1.18885
Pakistan	4.177548	1.012146	0.609716	2.626224	-0.21447	4.033621	0.143927
Philippines	5.096205	1.404312	3.132572	0.62213	0.16947	5.328484	-0.23228
SA	2.718561	-0.02413	5.471088	-3.05307	0.370118	2.764013	-0.04545

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

Table 7:Results of Growth Accounting with Human Capital and without Natural Capital for Developing Countries during 1995-2018.

Country	Cl(%)	CK(%)	CH(%)	TC(%)	TFPG(%)	% point difference*
Argentina	1.690557	0.783395	0.203021	2.676974	-0.25221	0.027178
Bang	-0.02277	4.899975	0.880388	5.757589	0.060433	0.060846
Brazil	0.015909	0.46746	1.809661	2.29303	0.035739	0.013632
China	0.044736	3.179574	6.125822	9.350132	-0.26303	-0.47676
Egypt	0.283903	4.53983	-0.21894	4.604795	-0.06663	0.050393
Indo	-1.4407	5.396333	0.894784	4.850421	-0.48612	0.125341
India	0.373904	2.320352	3.86376	6.558017	0.052761	-0.05901
Chili	0.04149	4.750997	-0.77307	4.019418	-0.01463	0.069493
Mexico	2.196129	0.28405	0.225935	2.706114	0.042324	0.01774
Morocco	-0.02359	1.714277	2.418661	4.10935	0.198696	-0.06816
Nigeria	-0.2999	0.319596	4.081914	4.101614	1.173976	0.014874
Pakistan	1.312463	0.383653	2.35144	4.047556	0.129992	0.013935
Philippines	1.472392	3.045455	0.878884	5.39673	-0.30053	0.068246
SA	-0.04036	5.473268	-2.58495	2.847958	-0.1294	0.083946

Source: Author's Computation * diff between TFPGs of table 6 and 7

Table 8: Results of Growth Accounting with Natural Capital but without Human Capital for Developing Countries during 1995-2018.

Country	GGDP (%)	Cl (%)	CK (%)	CN (%)	TC (%)	TFPG (%)	Percent point Diff*
Argentina	2.424761	1.663487	0.932739	0.054336	2.650562	-0.2258	0.000765
Bang	5.818022	0.042185	5.902379	-0.1403	5.804269	0.013753	0.107527
Brazil	2.328769	-0.68698	1.324482	1.666523	2.304023	0.024746	0.024625
China	9.087099	0.099455	8.41329	0.567409	9.080154	0.006945	-0.74674
Egypt	4.53816	0.214478	4.264479	0.078544	4.557501	-0.01934	0.003099
Indo	4.364301	-2.87607	6.502178	0.982161	4.608274	-0.24397	-0.11681
India	6.610778	0.350661	7.273944	-1.02137	6.603232	0.007546	-0.0138
Chili	4.004791	-0.04121	3.75463	0.22643	3.939847	0.064944	-0.01008
Mexico	2.748438	2.006193	0.690348	-0.00442	2.692119	0.056319	0.003745
Morocco	4.308046	-0.0183	4.174368	-0.06921	4.086858	0.221188	-0.09065
Nigeria	5.27559	0.090522	2.908212	-0.0149	2.983835	2.291755	-1.1029
Pakistan	4.177548	2.056808	2.144612	-0.05896	4.142465	0.035083	0.108844
Philippines	5.096205	1.681387	3.407115	0.230676	5.319179	-0.22297	-0.00931
SA	2.718561	-0.05225	2.66454	0.2266	2.8389	-0.12066	-0.1661

Source: Author's Computation* difference of TFPGb between table 6 and 8

Table 8A : Growth Accounting with Capital and Labour for developing Countries

Country	Cl (%)	CK(%)	TC(%)	TFPG(%)	% point diff
Arg	1.746999	0.917078	2.664077	-0.23932	-0.01351
Bang	0.032736	5.705629	5.738366	0.079656	0.065903
Brazil	-0.13607	2.795637	2.65957	-0.3308	-0.35555
China	0.166843	9.166561	9.333403	-0.2463	-0.25325
Egypt	0.292935	4.323053	4.615987	-0.07783	-0.05849
Indo	-1.67828	6.57885	4.90057	-0.53627	-0.2923
India	0.370517	5.973135	6.343652	0.267126	0.25958
Chili	0.011866	4.09682	4.108686	-0.1039	-0.16884
Mexico	2.445084	0.219794	2.664878	0.08356	0.027242
Morocco	-0.01491	4.087267	4.072357	0.23569	0.014501
Nigeria	0.091106	2.895781	2.986887	-2.93413	-5.22589
Paki	2.113627	2.029595	4.143222	0.034325	-0.00076
Phillipns	1.973198	3.449003	5.422201	-0.326	-0.10302
SA	-0.06142	2.946091	2.884668	-0.16611	-0.04575

Source : Authors' computation * difference between table 8A and 8

Table 8A reports the results of growth accounting when we consider L and K in MFP for the developing countries. It is also evident that for majority of the countries the contribution of TFPGs to growth of real GDP are over estimated in the absence of natural capital i.e. there is an upward bias in the estimation of role of TFP on growth and it is reflected by the negative values of differences of TFPGs between **table 8A** and **table 8**

Section – VI: the Cross Country Growth Accounting Results of the Dynamic Panel Regression

It is often found that the cross country growth estimation along with the estimation of convergence are subject to some limitations depending on the inconsistent estimation procedures because of the presence of two sources of inconsistency. The first one relates to the incorrect treatment of the country specific effects representing the differences in technology or base level efficiency thereby giving rise to the omitted variable bias such that effects are uncorrelated with the other explanatory variables. The second one arises due to the strong role of endogeneity of the some of the explanatory variables. For instance in our growth accounting though we have the data base on the stock of all the capitals (viz; physical capital, human capital and natural capital) used in the MFP, these capitals are accumulative in nature such that the process of accumulation and decumulation especially in case of physical and natural capital take place simultaneously due to investment and so the endogeneity problem crops up in cross country growth accounting. Further the base level incomes of the countries are likely to produce some impact on TFP and the stock of capital of the countries. To remove these problems of inconsistency we use the dynamic panel with generalized method of moments estimator such that all the variables are expressed in per capita terms and we also use the lagged dependent as independent variable and all other independent variables in our MFP as instrumental variables. The GMM frame work deals consistently and efficiently with the estimation problems of endogeneity and the country specific effect. To test the identifying assumption we apply the Sargan test of overidentifyng restrictions, the robustness of which is determined by the Chi-square distribution of the Sargan statistics. Further for testing the strict exogeneity assumption of the explanatory variables we perform Hausman test. The results of our cross country growth accounting done through the DPM with GMM for the developed and developing country panel are give in tables 9-11. It is evident from the estimated results of the developed countries that the cross country growth accounting results are compatible with our country specific growth accounting results especially if we consider the role of natural capital. We find that the elasticities of the growth contributions of the explanatory factors labor, physical 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 income growth over the period through their production elasticities. However, although the production elasticity of the natural capital is found to be positive it is statistically insignificant in its contribution to the cross country variations in the growth of per capita income. It is further established that the elasticity of growth contribution of physical capital is highest (1.34%) which is followed by that of labour (0.99%) and human capital (0.16%) respectively. If we drop the variable natural capital from the panel regression we find negligible change in production elasticities of the growth of factor inputs with marginal increase in the statistically significant output elasticity of growth of capital followed by a marginal fall in the same for labor and human capital with their positive signs. The highly statistically significant values of the Wald Chi-square along with their very high P-values in both of the two cases indicate correct specifications of the model with its robustness of estimation. Further the Chi-square values of the Sargan test along with their P-values in both the two cases 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 -11. The negative coefficient of the variable Log y_0 reveals the converging tendency of the countries towards their steady state growth path nevertheless the coefficient is low statistically significant. This can be called as the club convergence amongst the developed countries arising out of the strong competition amongst themselves for catching up frontier technology as well as developing the best possible highly productive technology say ICT and robotic technology. On the whole we can 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 human and physical capital along with that of labour, though relatively small in value, are of crucial importance in sustaining the cross country and country specific growth of the developed countries of our panel.

We find somewhat different results of our cross country growth accountings for the set of developing countries such that in this case the elasticities of growth contributions of capital, human capital and natural capital are found to be highly statistically significant with their positive signs when the accounting analysis is done by considering all the four factors (**see table -10**). So it is plausible to conclude 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 growth of real GDP of the developing countries over the period through their respective production elasticities. However the elasticity of growth contribution of labour is found to be very small positive but it is statistically insignificant. The obvious possible explanations may be that the developing countries are highly natural resource dependent. Further the liberalization of trade, investment and finance has expedited the smooth cross country movement of modern capital goods, technologies which are basically non-rival in nature. During the age of ICT and larger user use of intangible capitals the developing countries are also trying their level best to catch up the global technological frontier and the global productivity frontier. The insignificant elasticity of labor also indicates that the developing countries are also using various labor saving technologies. That is why the unemployment problem is increasing in such countries rapidly. Once again the highly statistically significant values of the Wald Chi-square along with their very high P-values in both of the two cases indicate correct specifications of the model with its robustness of estimation. Further the Chi-square values of the Sargan test along with their P-values in both the two cases also clearly indicate the overall validity of the instruments in analyzing the sample analog of the moment conditions used in our estimation process. Interestingly the small positive coefficient of the

initial levels of income. However, reveals the diverging tendency of the countries from their steady state growth path nevertheless the coefficient is low statistically significant (see table-11).

Table-9: Dynamic Panel Regression Results of Developed Countries

With Natural Capital			Without Natural Capital		
Dependent Variable: dlnY			Dependent Variable: dlnY		
Variable	Coefficient	p-value	Variable	Coefficient	p-value
dlnPCY L1	.0000512	0.99	dlnPCY L1	.0005036	0.96
dlnPCL	.9850734	0.000	dlnPCL	.9825763	0.000
dlnPCK	1.335253	0.000	dlnPCK	1.347751	0.000
dlnPCH	.1593946	0.000	dlnPCH	.1587093	0.000
dlnPCN	.0096024	0.503			
Wald chi2(5) = 338.91 Prob> chi2 = 0.0000 Sargan test of overidentifying restrictions chi2(231) = 318.5916 Prob> chi2 = 0.0001			Wald chi2(4) = 339.31 Prob> chi2 = 0.0000 Sargan test of overidentifying restrictions chi2(231) = 317.9969 Prob> chi2 = 0.0001		

Source : Authors' Computation

Table-10: Dynamic Panel Regression Results of Developing Countries

Dependent Variable: dlnY			Dependent Variable: dlnY		
with Natural Capital			without Natural Capital		
Variable	Coefficient	p-value	Variable	Coefficient	p-value
dlnPCY L1	-.0027299	0.7	dlnPCY L1	-.0037477	0.6
dlnPCL	.0006016	0.6	dlnPCL	.001353	0.3
dlnPCK	.6103969	0.00	dlnPCK	.7748432	0.00
dlnPCH	.1355737	0.00	dlnPCH	.1233768	0.00
dlnPCN	.1066468	0.00			
Wald chi2(5) = 135.26 Prob> chi2 = 0.0000 Sargan test of overidentifying restrictions chi2(198) = 260.7546 Prob> chi2 = 0.0018			Wald chi2(4) = 111.54 Prob> chi2 = 0.0000 Sargan test of overidentifying restrictions chi2(198) = 286.5164 Prob> chi2 = 0.0000		

Source : Authors' Computation

Table-11: Panel Results for Convergence Test

Developed Country			Developing Country	
Dependent Variable: dlnY			Dependent Variable: dlnY	
Variable	Coefficient	p-value	Coefficient	p-value
dlnPCY L1	.0001103	0.997	-.0027299	0.711
lnY_0	-.0002451	0.157	.0005402	0.295
dlnPCL	.9819466	0.000	.0006016	0.693
dlnPCK	1.336192	0.000	.6103969	0.000
dlnPCH	.1556852	0.000	.1355737	0.000
dlnPCN	.0086436	0.547	.1066468	0.000
Wald chi2(6) = 725.47 Prob> chi2 = 0.0000			Wald chi2(6) = 725.47 Prob> chi2 = 0.0000	

Source : Authors' Computation

Section VII. Concluding Remarks

In this paper we have done country specific growth accounting exercises by using MFP for the two sets of countries (developed and developing) for the estimation of growth contributions of four factor inputs (labor, capital, human capital and natural capital) to growth of the real GDP of the countries so as to have an explicit insight about the role of natural capital and also of human capital on productivity growth of the countries. Instead of imposing the factor shares for determination of growth contributions of inputs we have estimated the production elasticities of the factors through the country specific regression analysis and then computed the share weighted growth contributions of each factor inputs vis-à-vis the TFPG in terms of Solow residuals. This exercise is done thrice; first by considering all factors, then by dropping only the natural capital variable and finally by dropping the argument human capital.

In case of developed countries we find that the productivity growth of nine countries amongst the 16 countries is very small negative during the period while that of other are found to be positive when we consider the four factor inputs in the MFP. However, the growth contribution of natural capital is found to assume poor negative values even in eight countries including some resource rich countries also. Conversely the growth contributions of human capital are found to be small negative in seven countries coupled with small positive values of the same in other countries. Surprisingly the growth contributions of capital are found to be higher in all the countries as compared to that of labor in varying degrees, albeit growth contributions of labor in Japan and Sweden are found to be negative. Minor variations in the growth contributions of human capital are found to persist when we drop the natural capital such that the same have become negative in seven countries. While the growth contributions of labor have become negative in four of our sample countries, the same for capital has become negative in Canada. Interestingly the small negative values of TFPG are found only in four countries in this case. However, our growth accounting results without human capital but including physical capital , natural capital and labour reveal that the growth contribution of capital have fallen in some countries which are accompanied by rise in the growth contribution of capital in some other countries. The negative values of the differences between the TFPG with natural capital and that without natural capital for 12 countries clearly reveal that there has been an upward bias (or over-estimation) of TFPG in absence of natural capital in these countries.

On the other hand,the estimation of growth accounting results with all four factors reveal that in majority of the developing countries the average percentage growth contributions of the natural capital are positive with the exception of five countries where it is negative. On the other hand, for the majority of the countries excepting Mexico and South Africa, the growth contributions of human capital are found to assume positive values with some variations. Conversely, the growth contribution of physical capital in all the developing countries of our sample are found to be positive in varying degrees with higher values for some of the countries. Surprisingly, the growth contribution of labour is found to be negative in 8 countries out of the 14 countries. The contributions of TFPG to the growth of GDP across these countries are very poor positive along with their negative contribution in 7 countries, though negligible these are. The dropping of the variable natural capital from the growth accounting analysis ceteris paribus and then the human capital keeping others unchanged produce varying impact though not substantial on the growth contributions of capital, human capital and labour and also on the TFPG. Interestingly, we find that the exclusion of natural capital and later the human capital have resulted into overestimation of productivity growth for some countries and underestimation for some others. Our cross-country growth accounting results both for the developed and developing countries are found to be mostly compatible with that of our country specific growth accounting results such that the elasticity of growth contribution of the factor inputs labour, capital and human capital are found to be positive significant in the developed countries, that of natural capital being positive insignificant. However, in case of developing countries the elasticities of growth contributions of capital, human capital and natural capital are found to be positive and highly statistically significant. While the developed countries reveal a converging tendency towards their steady state growth of per-capita income, the diverging tendencies are found to persist across developing countries.

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Appendix Table-I : Summary Statistics of The Average Values of Inputs and their dispersion of Developed Countries

Country		L	K	H	N
AUS	SD	1.99E+09	1.31E+12	2.02E+12	6.49E+11
	Mean	1.84E+10	5.42E+12	8.49E+12	1.51E+12
AUT	SD	1.52E+08	2.34E+11	3E+11	1.07E+10
	Mean	6.79E+09	2.03E+12	2.53E+12	1.02E+11
Canada	SD	2.09E+09	1.17E+12	2.33E+12	2.83E+11
	Mean	2.93E+10	6.82E+12	1.62E+13	1.35E+12
DEN	SD	1.12E+08	1.3E+11	2.66E+11	1.29E+10
	Mean	3.9E+09	1.56E+12	2.18E+12	7.85E+10
GER	SD	1.68E+09	1.45E+12	3.56E+12	6.37E+10
	Mean	5.42E+10	1.91E+13	2.53E+13	4.15E+11
FRA	SD	1.83E+09	1.56E+12	1.91E+12	4.54E+10
	Mean	4.01E+10	1.26E+13	1.94E+13	5.14E+11
ITA	SD	1.29E+09	9.51E+11	5.06E+11	1.8E+10
	Mean	3.96E+10	9.77E+12	1.14E+13	3.76E+11
Japan	SD	4.3E+09	1.79E+12	1.94E+12	4.48E+10
	Mean	1.16E+11	2.7E+13	3.84E+13	2.69E+11
Netherlands	SD	5.74E+08	3.82E+11	7.52E+11	2.05E+10
	Mean	1.18E+10	3.43E+12	5.9E+12	1.32E+11
Nor	SD	2.17E+08	2.75E+11	2.36E+11	1.12E+11
	Mean	3.49E+09	1.69E+12	2.72E+12	4.31E+11
Spain	SD	3.81E+09	1.12E+12	1.01E+12	2.03E+10
	Mean	3.01E+10	5.36E+12	9.2E+12	3.27E+11
South Korea	SD	1.59E+09	1.48E+12	2.07E+12	2.19E+10
	Mean	5.5E+10	4.76E+12	7.09E+12	1.39E+11
Sweden	SD	4.17E+08	1.93E+11	7.05E+11	3.01E+10
	Mean	7.26E+09	2.54E+12	3.29E+12	2.06E+11
Switzerland	SD	3.29E+08	2.45E+11	6.29E+11	4.26E+09
	Mean	6.87E+09	2.77E+12	5.48E+12	7.82E+10
USA	SD	2.78E+09	1.04E+12	2.52E+12	5.44E+10
	Mean	4.94E+10	9.44E+12	1.9E+13	3.16E+11
UK	SD	1.06E+10	9.94E+12	2.08E+13	1.15E+12
	Mean	2.56E+11	7.19E+13	1.66E+14	5.77E+12

Source: Authors' Computation; Here, L= Labour, K=Physical Capital, H= Human Capital and N= Natural Capital.

Appendix Table-II : Country Specific Regression Results for the Developed Countries

Country	L	K	H	N	R-squad (%)	L	K	H	R-squad(%)
AUS	**0.039022 (0.907)**	1.748004 (0.000)	-0.822 (0.05)	-0.03755 (0.12)	99.48 (0.000)	-0.0278028 (0.936)	1.664154 (0.000)	-0.7743645 (0.008)	99.44 (0.000)
AUT	0.8905144 (0.000)	1.071892 (0.000)	-0.2402692 (0.002)	0.0551143 (0.17)	99.22 (0.000)	0.8220615 (0.001)	1.078072 (0.000)	-0.1939668 (0.003)	99.18 (0.000)
CAN	1.205615 (0.000)	0.2041238 (0.079)	0.2910038 (0.026)	0.0958133 (0.000)	99.80 (0.000)	1.372374 (0.000)	-0.07957 (0.644)	0.6619445 (0.001)	99.42 (0.000)
DEN	0.6614084 (0.000)	0.9341288 (0.000)	0.1339777 (0.062)	-0.0138012 (0.660)	98.71 (0.000)	0.6629665 0.000)	0.8881345 (0.000)	0.1586009 (0.001)	98.76 (0.000)
GER	0.1033333 (0.019)	1.140994 (0.000)	0.2180262 (0.834)	-0.1640228 (0.309)	98.33 (0.0000)	0.4196479 (0.002)	1.053241 (0.000)	0.029172 (0.623)	98.32 (0.0000)
FRA	0.5329429 (0.066)	0.4041011 (0.095)	0.5632321 (0.008)	-0.2977956 (0.005)	97.74 (0.000)	0.9584221 (0.003)	0.0478994 (0.84)	0.6030608 (0.015)	96.73 (0.00)
ITA	0.8948673 (0.000)	0.1195938 (0.031)	0.1744481 (0.185)	0.079246 (0.381)	85.67 (0.000)	0.9602125 (0.000)	0.1376509 (0.011)	0.1667318 (0.201)	88.31 (0.000)
JAPAN	0.4509397 (0.051)	0.6971474 (0.000)	0.1676876 (0.191)	0.1662621 (0.000)	90.38 (0.000)	0.5978261 (0.062)	0.9557226 (0.0000)	-0.0575347 (0.723)	80.83 (0.000)
NETHER	0.6962041 (0.001)	1.125003 (0.000)	-0.2128573 (0.10)	-0.0771488 (0.16)	98.03 (0.000)	0.8427528 (0.000)	0.9441494 (0.000)	-0.18197 (0.171)	97.92 (0.000)
NOR	0.0849829 (0.76)	0.6554327 (0.000)	-0.1463308 (0.17)	0.1030243 (0.008)	96.27 (0.000)	**-0.0392848 (0.90)**	0.8751205 (0.000)	-0.2045802 (0.10)	94.83 (0.00)
SPAIN	0.5229847 (0.001)	0.3452948 (0.000)	0.01419 (0.89)	0.1665765 (0.002)	99.61 (0.000)	0.8014636 (0.000)	0.2919133 (0.000)	-0.2003716 (0.10)	99.37 (0.000)
SOUTH KOREA	0.490549 (0.002)	0.6708675 (0.000)	0.1738308 (0.015)	0.1918073 (0.012)	99.97 (0.000)	0.326557 (0.034)	0.7302082 (0.000)	0.2077762 (0.010)	99.61 (0.000)
SWEDEN	-0.79918 (0.112)	1.086787 (0.209)	0.6140547 (0.042)	-0.0257736 (0.89)	96.33 (0.00)	-0.7872687 (0.1)	1.094943 (0.19)	0.591127 (0.01)	96.93 (0.000)
SWITZ	0.3508844 (0.16)	1.730529 (0.000)	-0.244689 (0.06)	-0.0428543 (0.4)	99.17 (0.000)	0.380386 (0.113)	1.678812(0.000)	-0.2204039 (0.08)	99.18 (0.000)
UK	**-0.1098016 (0.5)**	1.347847 (0.000)	0.2653279 (0.007)	-0.1148234 (0.000)	98.58 (0.000)	**0.1706058 (0.5)**	1.097994 (0.000)	0.2497395 (0.05)	97.14 (0.000)
US	0.4275051 (0.003)	0.8961784 (0.000)	0.1617039 (0.11)	-0.0297877 (0.13)	99.84 (0.000)	0.5085029 (0.000)	0.8456067 (0.00)	0.1586462(0.13)	99.83 (0.00)

Source : Authors' Computation. Figures in parentheses are p-values.

Appendix Table-III : Summary Statistics of The Average Values of Inputs and their Dispersion for Developing Countries

Country		L	K	H	N
Argentina	SD	3.51E+09	2.28E+11	7.46E+11	1.16E+11
	Mean	3.03E+10	1.16E+12	2.17E+12	5.91E+11
Bang	SD	75581979	2.14E+11	4.26E+11	3.92E+10
	Mean	2.36E+09	3.96E+11	1.16E+12	1.48E+11
Brazil	SD	60878794	9.26E+11	2.16E+12	7.45E+11
	Mean	2.08E+09	5.07E+12	1.34E+13	2.35E+12
China	SD	66323801	1.48E+13	4.64E+13	3.51E+12
	Mean	2.36E+09	2.1E+13	8.8E+13	8.85E+12
Egypt	SD	7.79E+09	7.32E+10	2.25E+11	1.28E+11
	Mean	5.01E+10	2E+11	8.6E+11	3.5E+11
Indonesia	SD	2.85E+10	9.43E+11	1.35E+12	2.87E+11
	Mean	2.07E+11	2.59E+12	4.69E+12	1.25E+12
India	SD	8.85E+10	2.03E+12	4.64E+12	9.78E+11
	Mean	1.12E+12	4.18E+12	1.15E+13	2.76E+12
Chili	SD	1.8E+09	2.31E+11	4.28E+11	1.79E+11
	Mean	1.5E+10	5.96E+11	1.48E+12	4.01E+11
Mexico	SD	8.73E+09	8.34E+11	8.13E+11	1.17E+11
	Mean	7.12E+10	4.07E+12	5.23E+12	9.03E+11
Morocco	SD	5.77E+11	9.61E+10	9.06E+10	6.24E+10
	Mean	3.62E+11	2.89E+11	3.61E+11	1.46E+11
Nigeria	SD	1.67E+12	1.71E+11	1.19E+12	1.45E+11
	Mean	1.49E+12	7.48E+11	1.96E+12	1.12E+12
Pakistan	SD	2.58E+10	8.8E+10	4.71E+11	4.54E+10
	Mean	1.26E+11	4.55E+11	1.55E+12	4.19E+11
Philippines	SD	1.09E+10	1.42E+11	4.37E+11	3.79E+10
	Mean	7.14E+10	5.63E+11	1.66E+12	2.17E+11
SA	SD	1.14E+11	1.59E+11	3.37E+11	1.03E+11
	Mean	6.71E+10	8.82E+11	1.55E+12	3.86E+11

Source : Authors' Computation; Here, L= Labour Hour, K=Physical Capital, H= Human Capital and N= Natural Capital Countries

Appendix Table-IV : Country Specific Regression Results for the Developing Countries

With All Factor Inputs						Without Natural Capital			
	L	K	H	N	Adj R-squad	L	K	H	Adj R-squad
Argentina	0.938401 (0.000)	0.23968 (0.001)	0.102288 (0.0024)	0.118488 (0.0026)	98.62 (0.00)	1.168224 (0.00)	0.279707 (0.001)	0.046297 (0.1)	98.29 (0.00)
Bang	**-0.07727 (0.4)**	0.65351 (0.00)	0.13333 (0.01)	-0.01749 (0.02)	99.97 (0.00)	**-0.10545 (0.3)**	0.627762 (0.00)	.1790616 (0.02) .	99.97 (0.00)
Brazil	0.552114 (0.2)	0.257573 (0.00)	0.718018 (0.00)	0.15416 (0.01)	99.67 (0.00)	**-0.04154 (0.9)**	0.187106 (0.00)	1.006249 (0.01)	99.48 (0.00)
China	**-0.09173 (0.8)**	0.514365 (0.06)	0.504794 (0.1)	0.092348 (0.03)	99.76 (0.000)	**0.182255 (0.6)**	0.298129 (0.2)	0.76782 (0.03)	99.70 (0.00)
Egypt	0.095658 (0.2)	0.729605 (0.00)	**0.036283 (0.5)**	0.034484 (0.02)	99.87 (0.00)	0.13161 (0.1)	0.806002 (0.00)	**-0.05447 (0.3)**	99.84 (0.00)
Indo	-0.93956 (0.02)	1.011238 (0.002)	0.210442 (0.003)	**0.165401 (0.2)**	**98.34 (0.00)**	-0.67293 (0.03)	0.989576 (0.00)	0.241647 (0.00)	98.30 (0.00)
India	0.327938 (0.00)	0.750628 (0.01)	0.306835 (0.00)	-0.17413 (0.00)	99.95 (0.00)	0.341711 (0.01)	0.338981 (0.00)	0.657789 (0.00)	99.90 (0.00)
Chili	**-0.0443 (0.8)**	0.62648 (0.00)	**0.03959 (0.7)**	0.073034 (0.00)	99.37 (0.00)	**0.035609 (0.8)**	0.831725 (0.00)	-0.16829 (0.1)	99.04 (0.00)
Mexico	0.986401 (0.00)	0.252238 (0.06)	**-0.01388 (0.8)**	-0.10904 (0.09)	99.11 (0.00)	1.084463 (0.00)	**0.09771 (0.3)**	0.08361 (0.03)	99.02 (0.00)
Morocco	-0.00478 (0.00)	0.39095 (0.00)	0.785978 (0.00)	-0.0944 (0.01)	99.64 (0.00)	**-0.00197 (0.3)**	0.372246 (0.00)	0.678878 (0.00)	99.54 (0.00)
Nigeria	-0.08419 (0.00)	**0.065319 (0.7)**	0.459982 (0.00)	**-0.04457 (0.6)**	**99.54 (0.00)**	-0.08296 (0.00)	**0.120294 (0.4)**	0.450877 (0.00)	97.11 (0.00)
Pakistan	**0.347397 (0.2)**	**0.20756 (0.5)**	0.611624 (0.00)	-0.14517 (0.09)	99.56 (0.00)	0.450474 (0.2)	**0.130603 (0.7)**	0.547629 (0.00)	99.41 (0.00)
Philippines	0.636036 (0.00)	0.806511 (0.00)	0.167922 (0.09)	0.109897 (0.07)	99.66 (0.00)	0.66687 (0.00)	0.784082 (0.00)	0.237224 (0.01)	99.62 (0.00)
SA	-0.0196 (0.07)	2.115069 (0.00)	-0.98538 (0.00)	0.143425 (0.00)	98.00 (0.00)	-0.03278 (0.00)	2.115912 (0.00)	-0.83429 (0.00)	97.18 (0.00)

Figures in parentheses are p-values. Source : Authors' Computation

Appendix table IIA :Inter-active regression results of selected developed and developing countries

	β_L	βk	β_H	β_N	β_{KH}	Adj. R-squad
ARG	**0.938398 (0.00)**	**0.13739 (0.1)**		**0.118489 (0.02)**	**0.102289 (0.01)**	**98.62 (0.00)**
ARG Without Natural Cap.	**1.168224 (0.00)**	**0.23341 (0.01)**			**0.046297 (0.18)**	**98.29 (0.00)**
Canada	**1.205614 (0.00)**	**-0.08693 (0.7)**		**0.095812 (0.00)**	**0.291032 (0.02)**	**99.8 (0.00)**
Canada without N	**1.372363 (0.00)**	**-0.74153 (0.04)**			**0.661955 (0.0)1**	**99.42 (0.0)**
China	**0.084189 (0.7)**	**-0.11588 (0.7)**		**0.144729 (0.01)**	**0.525539 (0.03)**	**99.88 (0.00)**
China Without N	**0.182225 (0.6)**	**-0.4697 (0.4)**			**0.767823 (0.04)**	**99.7 (0.00)**
Denmark	**0.661409 (0.00)**	**0.800154 (0.00)**		**-0.0138 (0.6)**	**0.133977 (0.06)**	**98.71 (0.00)**
Denmark without N	**0.662967 (0.00)**	**0.729535 (0.00)**			**0.158601 (0.001)**	**98.76 (0.00)**
Egypt	**0.095664 (0.2)**		**-0.69329 (0.001)**	**0.034486 (0.02)**	**0.72959 (0.00)**	**98.87 (0.00)**
France	**0.532914 (0.06)**		**0.159085 (0.6)**	**-0.29781 (0.05)**	**0.40413 (0.09)**	**97.74 (0.00)**
France Without N	**0.958399 (0.003)**		**0.555111 (0.2)**		**0.047926 (0.8)**	**96.73 (0.00)**
Germany	**0.546725 (0.01)**		**-1.13094 (0.00)**	**-0.05325 (0.3)**	**1.152716 (0.00)**	**98.33 (0.00)**
Germany Without N	**0.656022 (0.01)**	**1.176754 (0.00)**			**-0.04145 (0.6)**	**98.32 (0.00)**
Netherlands	**0.696193 (0.001)**		**-1.33788 (0.00)**	**-0.07715 (0.15)**	**1.125016 (0.00)**	**98.03 (0.00)**
Netherlands without N	**0.842748 (0.00)**		**-1.12613 (0.00)**		**.9441554 . (0.00)**	**97.92 (0.00)**
Philippines	**0.636035 (0.00)**	**0.638586 (0.001)**		**0.109895 (0.07)**	**0.167925 (0.09)**	**99.66 (0.00)**
	0.666868 (0.00)	**0.546856 (0.002)**			**0.237226 (0.01)**	**99.62 (0.00)**
UK	**0.475625 (0.01)**		**-0.54093 (0.02)**	**-0.04943 (0.15)**	**0.757775 (0.00)**	**98.89 (0.00)**
UK without N	**0.638889 (0.01)**	**0.279454 (0.06)**			**0.2848 (0.00)**	**98.8 (0.00)**

Source :Authors' Computation. Figures in parenthesis represent corresponding p-value

Appendix Table V: List of Countries

Developed Countries	Developing Countries
Australis	Argentina
Austria	Bangladesh
Canada	Brazil
Denmark	China
Germany	Egypt
France	Indonesia
Italy	India
Japan	Chili
Netherlands	Mexico
Norway	Morocco
Spain	Nigeria
South Korea (Republic of Korea)	Pakistan
Sweden	Philippines
Switzerland	South Africa
United Kingdom	
United States	

Appendix -A

Growth accounting based on user cost share weighted growth contribution of the factor inputs .

In this section we report the results of our country specific growth accounting such thatcontributions of each factor such as labor, capital , human capital and natural capital estimatedby multiplying the rate of change in the factor inputs weighted by their user cost shares to total input cost of production of output of the economy. The differences between the growth rates of real GDP and the sum the growth contribution of factors give the TFPGs. For growth accounting we consider the same neo-classical production function as

$$Y_{(it)} = A_{(it)} F(L_{(it)}, K_{(it)}, H_{(it)}, N_{(it))})\text{.............}(I)$$

Where the symbols are of the same meaning. To decompose the growth the growth of output we take log differences as

$$\Delta \log Y_{lt} = \Delta \log A_t + s_k \Delta \log K_t + s_L \Delta Log\ L_t + s_h \Delta \log\ H_t + s_n \Delta Log\ N_t\text{.........}(II)$$

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 shares we use the Pen world tables ,version 10where 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. Since the per cent shares of rental value of natural capital are given in the world Bank data base we compute the total volume of rental value of the same from the series of values of GDP of each country. Then we take the sum total of the service or user costs of human capital and natural 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 andexpress 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 equal to one.We repeat same process when drop factor input from MFP and have the respective user cost shares (s_j)of the factors under consideration. We then use these s_j for computing the growth contributions of the factors the results of which are given in the appendix table A-1, A-2, A-3 and A-4for the developed countries and the same for the developing countries are given in B-1,B-2, B-3 and B-4. Our growth accounting results are more or less compatible with the same that we have computed by using the respective production elasticities of the factors determined through the country specific production function analysis.

Surprisingly the differences between the values of the TFPG of table A-2 and A-1 are mostly negative across the countries which clearly indicates upward bias in the estimation of the contribution of technology in the conventional MFP due to mismeasurement of factor inputs especially the non inclusion of the role of natural capital. This is also found when we include human capital in the MFP (see the Tables A-4 and A-3.). Actually what we find that as we gradually incorporate the natural capital and human capital in the MFP and estimate growth contributions of the factors the relative role of the contributions of the TFPG on the growth of GDP of the countries becomes insignificant and even negative for some countries. For the developing countries the growth contribution of TFPG with L and K but without N (Table B-1) and the same with N (B-2) are found to be positive in almost all the countries excepting Egypt such that the difference between TFPGs in terms of percent point are found to be negative for six countries there by indicating the upward biasness in the estimation of TFPGs in the absence of natural capital. However, the contribution of natural capital are found to be positive in almost all the developing countries, the possible reason being the larger dependence of the developing countries on natural capital in varying degrees. Almost similar results are found in B-3 and B-4.

Table A-1 :Cost Share Weighted Growth Accounting for Developed Countries (1995-2018)

Country	Cl (%)	CK(%)	TC(%)	TFPG(%)
AUS	0.848117	1.435752	2.283869	0.744083
AUT	0.187377	0.766276	0.953653	0.794824
CAN	0.773432	0.988839	1.762271	1.048317
DEN	0.199693	0.536113	0.735806	0.770667
GER	0.098111	0.458639	0.55675	0.835157
FRA	0.318568	0.717582	1.03615	0.542707
ITA	0.18791	0.605306	0.793216	-0.2309
JAP	-0.14808	0.471247	0.323168	0.389008
NETH	0.539627	0.701204	1.240831	0.640696
NOR	0.419258	1.28436	1.703618	0.129734
SPAIN	1.106796	1.080338	2.187134	-0.11971
S.Korea	0.029544	1.703837	1.733381	2.299333
Sweden	0.401515	0.550984	0.952499	1.46893
SWITZ	0.423946	0.428826	0.852772	1.14069
UK	0.473585	0.724792	1.198377	0.79633
US	0.482371	0.706445	1.188816	1.140026

Source: Authors' Computation TFPG (A) => TFPG of respective tables

Table A2 :Cost Share Weighted Growth Accounting for Developed Countries (1995-2018)

Country	Cl(%)	CK(%)	CN(%)	TC(%)	TFPG(%)	% point Difference between TFPG of A2and TFPG A1)
AUS	0.808537	1.371294	0.267254	2.447085	0.580868	-0.163215
AUT	0.187045	0.765029	0.001755	0.95383	0.794647	-0.000177
CAN	0.768674	0.955152	0.101707	1.825533	0.857301	-0.191016
DEN	0.199513	0.530317	0.015102	0.744932	0.76154	-0.009127
GER	0.097875	0.458104	0.003127	0.559107	0.832801	-0.002356
FRA	0.31841	0.717214	0.000316	1.035941	0.542917	0.00021
ITA	0.187892	0.604714	0.00026	0.792865	-0.23055	0.00035
JAP	-0.14807	0.47117	0.000399	0.323494	0.388681	-0.000327
NETH	0.537567	0.697358	0.010606	1.245531	0.635996	-0.0047
NOR	0.386134	1.176836	0.33564	1.89861	-0.06526	-0.194994
SPAIN	1.106316	1.079802	0.000457	2.186575	-0.11915	0.00056
S.Korea	0.029604	1.703399	0.000551	1.733553	2.299161	-0.000172
Sweden	0.378733	0.539473	0.013017	0.931222	1.518428	0.049498
SWITZ	0.423889	0.428758	0.000173	0.85282	1.140642	-4.8E-05
UK	0.470454	0.719516	0.013093	1.203064	0.791644	-0.004686
US	0.478895	0.700213	0.027188	1.206296	1.122546	-0.01748

Source: Authors' Computation

Table A-3 : Cost Share Weighted Growth Accounting for Developed Countries (1995-2018)

Country	Cl(%)	CK(%)	CH(%)	TC(%)	TFPG(%)	Percent point Diff (A4-A3)
AUS	0.821749	1.391247722	0.09979174	2.312788844	0.829283335	-0.138988818
AUT	0.180405	0.737156394	0.055759225	0.973320417	0.848210914	0.030719542
CAN	0.773821	0.961564407	0.043295454	1.778681339	0.975123073	0.009709809
DEN	0.190011	0.509633108	0.093987884	0.79363171	0.80931802	0.013566061
GER	0.09428	0.444756975	0.051402555	0.590439743	0.807170675	0.086751145
FRA	0.306523	0.690449252	0.055803997	1.052776022	0.564941856	0.043178324
ITA	0.18273	0.588935969	0.009896145	0.781562155	-0.183350095	-0.0084281
JAP	-0.14508	0.461793091	-0.003775303	0.312936486	0.514227747	-0.005232017
NETH	0.521774	0.677851668	0.061780755	1.26140599	0.733115294	-0.004229266
NOR	0.40158	1.22755144	0.033980447	1.663111624	0.357482834	-0.276730822
SPAIN	1.078188	1.051782398	0.025360253	2.155331046	-0.023130064	0.03703189
S.Korea	0.028763	1.673240215	0.069882707	1.771885903	2.464282939	-0.00248093
Sweden	0.367092	0.520981396	0.117502034	1.00557576	1.459094973	0.120390814
SWITZ	0.411364	0.415857827	0.04791488	0.875136226	1.110044154	0.092470102
UK	0.459185	0.703483726	0.051986741	1.214655669	0.850671865	0.016125924
US	0.467962	0.685304297	0.064246809	1.217512925	1.232633385	-0.030688525

Source: Authors' Computation

Table A-4: Cost Share Weighted Growth Accounting for Developed Countries (1995-2018)

Country	GGDP(%)	CL(%)	CK(%)	CH(%)	CN(%)	TC(%)	TFPG(%)
AUS	3.142072	0.747453	1.347169	0.100837	0.279833	2.47529218	0.690295
AUT	1.821531	0.153247	0.736931	0.057059	0.001786	0.94902319	0.87893
CAN	2.753804	0.736054	0.941853	0.043529	0.104319	1.82575472	0.984833
DEN	1.60295	0.144805	0.493725	0.097731	0.015803	0.75206406	0.822884
GER	1.39761	0.06207	0.442513	0.053369	0.003301	0.56125388	0.893922
FRA	1.617718	0.294767	0.689206	0.058179	0.000351	1.0425036	0.60812
ITA	0.598212	0.168806	0.59992	0.010601	0.000323	0.77965114	-0.19178
JAP	0.827164	-0.23108	0.470127	-0.00389	0.000394	0.23555148	0.508996
NETH	1.994521	0.493518	0.66952	0.062924	0.012202	1.23816515	0.728886
NOR	2.020594	0.347728	1.107145	0.048266	0.332795	1.83593382	0.080752
SPAIN	2.132201	1.050553	1.070146	0.026324	0.000474	2.14749526	0.013902
S.Korea	4.236169	0.006088	1.674447	0.073104	0.000578	1.75421695	2.461802
Sweden	2.464671	0.34095	0.503906	0.123795	0.012862	0.98151253	1.579486
SWITZ	1.98518	0.413409	0.419842	0.04813	0.000178	0.88155921	1.202514
UK	2.065328	0.452279	0.696715	0.05551	0.014073	1.21857797	0.866798
US	2.450146	0.450519	0.688595	0.064518	0.029121	1.23275282	1.201945

Source: Authors' Computation

For Developing Countries

Table B-1: Cost Share Weighted Growth Accounting (2015-2018)

Country	CL(%)	CK(%)	TC(%)	TFPG(%)
Arg	0.466979	1.618699	2.085678	0.153753
Bang	0.039935	4.936082	4.976017	0.674298
Brazil	-0.19054	1.257674	1.067132	1.201606
China	0.11815	5.110786	5.228936	3.454172
Egypt	7.750913	2.625302	10.37621	-5.94927
Indo	0.862774	3.104498	3.967272	0.225812
India	0.46062	3.900128	4.360748	2.028039
Chili	0.498586	2.956367	3.454953	0.446629
Mexico	0.957641	1.472881	2.430522	0.250332
Morocco	-0.91159	2.738335	1.826743	2.357468
Paki	1.381275	1.466884	2.848159	1.231763
Philippines	0.755521	2.416154	3.171675	1.782004
SA	0.466979	1.618699	2.085678	0.153753

Source : Authors’ Computation

Table B-2:- Cost Share Weighted Growth Accounting (2015-2018)

Country	CL(%)	CK(%)	CN(%)	TC(%)	TFPG(%)	%point Difference of TFPG betweenB-2and B-1
Arg	0.448596	1.568809	0.102827	2.120233	0.304528	0.150775
Bang	0.039101	4.889236	0.030067	4.958404	0.859618	0.18532
Brazil	-0.18489	1.220507	0.122275	1.157891	1.170878	-0.03073
China	0.116497	4.919781	0.265512	5.301789	3.78531	0.331138
Egypt	6.661485	2.388148	0.426459	9.476091	-4.93793	1.01134
Indo	0.805662	2.89671	0.238438	3.940811	0.423491	0.197679
India	0.448388	3.769918	0.165839	4.384145	2.226632	0.198593
Chili	0.447985	2.715441	0.53979	3.703216	0.301575	-0.14505
Mexico	0.919126	1.412015	0.064081	2.395223	0.353215	0.102883
Morocco	-0.87878	2.663001	0.15196	1.936183	2.371864	0.014395
Paki	1.359548	1.44343	0.027116	2.830094	1.347453	0.11569
Philippines	0.746341	2.389011	0.033827	3.169178	1.927027	0.145023
SA	-2.50156	1.222558	0.197362	-1.08164	3.800205	3.646452

Source : Authors' Computation

Table B-3: Cost Share Weighted Growth Accounting (2015-2018)

Country	GGDP(%)	CL(%)	CK(%)	CH(%)	TC(%)	TFPG(%)	% point Diff of TFPG betweenB-4and B-3
Arg	2.424761	0.456975	1.574149	0.100031	2.131155	0.108276	-0.03455
Bang	5.818022	0.039496	4.883419	0.052579	4.975494	0.674822	0.017613
Brazil	2.328769	-0.18475	1.219404	0.047941	1.082591	1.186147	-0.09076
China	9.087099	0.116974	5.059698	0.076005	5.252677	3.430431	-0.07285
Egypt	4.53816	7.608934	2.577193	0.0703	10.25643	-5.82948	0.900123
Indo	4.364301	0.853863	3.071446	0.027046	3.952354	0.24073	0.026461
India	6.610778	0.44989	3.806318	0.137153	4.393361	1.995426	-0.0234
Chili	4.004791	0.487629	2.896679	0.086438	3.470746	0.430835	-0.24826
Mexico	2.748438	0.9353	1.438507	0.056776	2.430583	0.250271	0.0353
Morocco	4.308046	-0.87442	2.65749	0.101107	1.884177	2.300035	-0.10944
Paki	4.177548	1.362542	1.446806	0.057537	2.866886	1.213036	0.018065
Philippines	5.096205	0.747714	2.39108	0.03624	3.175034	1.778646	0.002497
SA	2.718561	-2.5221	1.260569	0.05777	-1.20376	3.947152	-0.21088

Source : Authors' Computation

Table B-4: Cost Share Weighted Growth Accounting (2015-2018)

Country	GGDP%)	CL%)	CK%)	CH%)	CN%)	TC%)	TFPG%)
Arg	2.424761	0.438593	1.52426	0.100031	0.102827	2.16571	0.073721
Bang	5.818022	0.038662	4.836573	0.052579	0.030067	4.957881	0.692435
Brazil	2.328769	-0.1791	1.182237	0.047941	0.122275	1.17335	1.095389
China	9.087099	0.115321	4.868693	0.076005	0.265512	5.325531	3.357577
Egypt	4.53816	6.519506	2.340039	0.0703	0.426459	9.356303	-4.92936
Indo	4.364301	0.796751	2.863659	0.027046	0.238438	3.925893	0.267191
India	6.610778	0.437658	3.676108	0.137153	0.165839	4.416758	1.972029
Chili	4.004791	0.437028	2.655753	0.086438	0.53979	3.719009	0.182572
Mexico	2.748438	0.896785	1.377641	0.056776	0.064081	2.395284	0.285571
Morocco	4.308046	-0.84161	2.582156	0.101107	0.15196	1.993616	2.190596
Paki	4.177548	1.340815	1.423353	0.057537	0.027116	2.848821	1.2311
Philippines	5.096205	0.738533	2.363937	0.03624	0.033827	3.172537	1.781142
SA	2.718561	-2.44356	1.195543	0.05777	0.197362	-0.99288	3.736273

Source : Authors' Computation