Theoretical and Applied Economics
Volume XXVI (2019), No. 4(621), Winter, pp. 241-264

Exploring the role of institutions in cross country Malmquist productivity analysis: A two-stage double bootstrap DEA approach

Danish Ahmed SIDDIQUI
Karachi University Business School, University of Karachi, Pakistan
daanish79@hotmail.com
Qazi Masood AHMED
Institute of Business Administration, Karachi, Pakistan
qmasood@iba.edu.pk

Abstract. *This paper explore the role of institutions to enhance the productivity growth across countries using a two stage Double Bootstrap Data Envelopment Analysis (DEA). The productivity growth is calculated on the basis of Malmquist productivity index. It also explores the sources of productivity growth and the influence of different types of institutions (Siddiqui and Ahmed, 2013a) on them. In the first stage, productivity growth and its decompositions a) technological change and b) efficiency change are estimated for a period of 1990-2000 for 78 countries. In the second stage, the impact of institutions on these estimates is analyzed through a bootstrapped regression. Findings suggest that institutions played a strong and positive role in enhancing cross country productivity mainly through promoting technological change but the evidences of institutions influencing efficiency change are not found. This study also shows that institutions that curb corruption, bureaucratic inefficiencies, lax regulations and unfriendly business policies, tend to have a larger effect on productivity growth than other two indices that curb political rents and that reduces transactional risks. However when they are aggregated, their impact is more pronounced than their combined individual impacts.*

Keywords: institutions; Malmquist; DEA; productivity.

JEL Classification: C23, D24, Q22, O43, Z13.

1. Introduction

This study attempts to measure aggregate productivity growth across countries and how this productivity growth is affected by the quality of institutions. This study decomposes productivity into efficiency and technological change and the impact of institutions on both of these is analyzed using regression analysis. Siddiqui and Ahmed (2013b) showed that those countries that have better quality institutions, utilize their resources more efficiently.(1) The present study attempts to show that institutions not only improve productivity but also identify the channels through which productivity is increased using a two-stage procedure.(2) In the first stage, Malmquist productivity indices i.e. productivity growth and its components technological and efficiency change of 78 countries were calculated. These indices were calculated based on a non-parametric method developed by Fare et al. (1992) using DEA(3) for the period of 1990-00 and were corrected for the biasness and to construct confidence interval for providing statistical inferences using the methodology of Simar and Wilson (2000). In the second stage, these indices as dependent variables were regressed with other determinants of efficiencies including institutions using Bootstrap Linear regression.

Castellacci and Zheng (2008) and Dismuke and Sena (1999) employed two-stage regression analysis based on Malmquist productivity index and found that the productivity variation across nations was the most important determinant for sustainable growth. Baier et al. (2006), Hall and Jones (1999) and Klenow and Rodriguez-Clare (1997) found workers' productivity as important determinant of income per worker. Baier et al. (2006) estimated that about one fourth of output per worker is contributed by TFP growth in western countries; however, Productivity explains as much as 84% variance in output per worker across countries. (World Bank, 1993; Sarel, 1997; Nelson and Pack, 1999) provide the evidence of productivity growth as a major driver of economic performance in East Asian region. Similar results were obtained by (Abramovitz, 1956; Solow, 1957; Kendrick, 1961; Denison, 1985; Jorgenson et al., 1987; Maddison, 1995; Klenow and Rodriguez-Clare 1997a; Jones, 1997; Ark et al., 2008) for United States, and Sun (2004) for Taiwan.

Traditional studies on measurement of productivity are based on standard growth accounting that relies on restrictive specification and often takes the form of Cobb-Douglas production function.(4) They also employ inappropriate assumptions that lead to overestimation of the role of total factor productivity (TFP) (Caselli, 2005; Jerzmanowski, 2007; Brock and Durlauf, 2001). These include 1) All countries are fully efficient. 2) Factor markets are perfectly competitive, 3) constant and same elasticity across countries and 4) constant returns to scale.(5)

Applied literature offers different approaches to measure productivity that includes both parametric and non-parametric frontier models. A widely used parametric frontier approach to measure efficiencies is the stochastic frontier analysis (SFA) developed by Sealey and Lindley (1977).(6) In this approach, some of the above-mentioned assumptions are relaxed; however, it still has functional form restriction. Studies such as (Fare et al., 1994; Koop et al., 2000; Limam and Miller 2004; Osiewalski et al., 2000) applied this approach to aggregate production functions whereas (Sharma et al., 2007; Wu, 2000; Li and Tung, 2010; Gumbau-Albert, 1998, 2000) used this approach to estimate regional productivity within a country. Most of these studies found improved efficiencies as a main driver of productivity growth.

The non-parametric approach eliminates most of the abovementioned problems. DEA is considered a standard non-parametric methodology in performance investigation of firms and industries.(7) However, it also applies to aggregate production functions.(8) Productivity indices using DEA approach are normally calculated through Malmquist productivity index technique. Efficiency frontier is formed in this approach through mapping most efficient countries on the frontier, and relative efficiency is calculated from their distance from it. In this way, productivity is decomposed into technological change (shift in frontier through technological progress and innovation) and efficiency improvement (catching up to the frontier). Distance functions of Malmquist indices are measured using DEA. The benefit of this approach is that there are no subjective weights to combine different factors, and no specification of any particular functional form. It is also free from distribution assumptions made in SFA. However, there are some drawback of this analysis are mentioned below. First, that it attribute all the variations from the frontier to the inefficiency. Secondly, the estimator defines efficiency relative to the best practice observations in the sample, not the "true" frontier. An associated complication with inference is that since the true efficiency scores are not observed directly but are empirically estimated, they are serially correlated. Simar and Wilson (1998, 2000). Moreover, the asymptotic sampling distribution of the DEA estimator is generally very hard to derive (Kneip et al., 2005). Furthermore, if these estimates are used in the 2 stage procedure like in our case, the second stage variables might be correlated with inputs and outputs of productivity estimates thus implying that the error term must be correlated with the second-stage explanatory variables.

In order to overcome these deficiencies, SIMAR and WILSON (1998, 2000 and 2007) introduced a bootstrapping method that provides the means of incorporating a stochastic element into DEA, and obtain unbiased beta coefficients and valid confidence intervals. It is based on the idea that the unknown distribution of the difference between the true and estimated productivity score is approximated by the difference between the estimated and the bootstrapped productivity score. In the double bootstrap procedure, Malmquist productivity indices are bootstrapped in the first stage and in the second stage, they are regressed them on potential covariates with the use of a bootstrapped regression. A similar approach is also followed in Jeon and Sickles (2004).

There could be many determinants of productivity growth. However, large number studies attributed this role to institutions. For example (Hall and Jones, 1999; Olson et al., 1998, Bjørnskov and Foss, 2010; Chanda and Dalgaard, 2008) explained their influence in TFP growth through growth accounting approach. Lambsdorff (2003) used the SFA technique to measure institutional impact on productivity and its relationship was also being tested using DEA based nonparametric Malmquist productivity index approach (Baris Yoruk, 2007; Krüger, 2003; M del Mar and Javier, 2007). Nearly all of the above mentioned studies found a strong and positive influence of institutions including those that inhibit corruption. Theoretical models like Olson (1982), Baumol (1990) and North (1990) and recent models like Restuccia (2004), and Landon-Lane and Robertson (2005), also attribute lower productivity to barriers to technological adoption, as well as inefficient use of existing technology all due to weak institutions. There could be other determinants of productivity growth. Using Traditional growth accounting approach, Easterly and Levine (2003), Alcála and Ciccone (2004) focused on the impact of other determinants like trade openness and geography. However, productivity estimates that all of these studies produced could be biased due to limitation in their approaches as discussed above. Furthermore, the institutional proxies used in these studies might not fully represent the concept. They also fail to identify the channels through which these institutions could influence productivity.

In this study, productivity indices were calculated using the values of output, physical and human capital per worker were taken from the data set developed by Baier et al. (2006) which is more comprehensive than any other previously available data used in growth analysis. Data set representing institutional quality was taken from Siddiqui and Ahmed (2013b) in which three orthogonal factors were extracted covering the period from 1990 to 2000 and measuring different theoretical dimensions.(9) Their Index of Institutional Social Technologies (IIST) and its three orthogonal factors were identified through Principal Components Analysis (PCA) utilizing twenty-nine indicators covering 84 countries. This First factor of the IIST named Risk-reducing Technologies (SiiF1) refers to institutions that reduce the cost of protecting property rights and strengthen contract enforcement. These services include provision of public goods such as rule of law and justice. The Second factor named Factor of Institutional and Policy Rents (RiiF2), focuses on technologies that help to eliminate or minimize two kinds of rent – institutional and policy rents. Third factor named Factor of Political Rent (RpiF3) measures the extent of power granted by institutions to political authorities. Theoretical and economic intuitions of the indices and their principal components can be found in Siddiqui and Ahmed (2013a).

Various other databases also measure institutional quality and many of them widely are used in empirical literature. These include various commercial (PRS and BERI), or non-commercial (WEF; Global Integrity; Bertelsmann; POLITY; World Bank (Doing Business); Kaufmann at al 2008; Gwartney and Lawson 2008; Miller and Holmes 2009) sources. All these databases have several shortcomings that have been addressed in this dataset.(10)

2. Malmquist productivity indices methodology

Concept of Efficiency analysis and measurement was first developed by Farrell (1957), inspired by the earlier work of Debreu (1951) and Koopmans (1951). He defined efficiency as the ratio of observed values to optimal values of output and input relative to a given technology. Efficiency frontier is made up of these optimal values and acts as a benchmark. Country's relative efficiency $(E^{it})$is calculated as a ratio of radial distance between their inputs-outputs (y^{it}, x^{it}) and potential optimum inputs-outputs that lies on the frontier (y^{*t}, x^{*t}). Each country's efficiency can be calculated as $\left(E^{ot} = \frac{(y^{*t}, x^{*t})}{(y^{it}, x^{it})}\right)$.

Productivity change is calculated using Quantity indices that were first introduced by Malmquist (1953) as ratios of radial distance functions D (•) to measure efficiency change across time. These ratios of distance functions were first applied in productivity analysis to measure productivity change by Caves et al. (1982) and so were named Malmquist productivity indices. Färe et al. (1992,1994a and 1994) combined Farrell (1957) efficiency concepts with Caves et al. (1982) formalization of productivity change into Malmquist productivity indices that used DEA based methodology to measure distance function.[(11)]

Färe et al. (1992) modified Caves et al. (1982) radial distance functions incorporating inefficiency in technology and made the frontier of technology function piecewise linear. Radial Distance functions can be classified into output and input distance functions where Input (Output) oriented efficiency ($E_{i(o)}$) is calculated as the reciprocal of input (Output) distance function *($D_{i(o)}$)* Färe (1994a, p. 228).

In this study, output oriented Malmquist productivity change index is used. An input oriented index can also be used; however, since results from both indices would be the same (Thanassoulis, 2001, p. 182), this specification is more of a theoretical issue than a practical one. As shown in equation 1, Färe et al. (1994b) model, M_o^{t+1} is output oriented radial Malmquist productivity index representing the change year t+1 level of production (X^{t+1}, Y^{t+1}) as compared to previous year t level of production (X^t, Y^t) can be written in terms of output distance functions *(D_o)*as

$$M_o^{t+1}(y^{t+1},x^{t+1},y^t,x^t) = \sqrt{\frac{D_o^t(y^{t+1},x^{t+1}|CRS)}{D_o^t(y^t,x^t|CRS)} \times \frac{D_o^{t+1}(y^{t+1},x^{t+1}|CRS)}{D_o^{t+1}(y^t,x^t|CRS)}} \qquad \text{(Eq. 1)}$$

Where subscript *i* is input orientation, *t* is time period, *D* are distance functions under constant return to scale (CRS) technology (Charnes et al., 1978 model) and *y, x* are the output and input vectors.

This index is the geometric mean of two productivity indices. In the ratio form, the value greater than one means current year productivity is more than the previous year, hence it indicates positive productivity growth from year *t* to *t+1*. The underlying assumptions include piecewise linear shape of technology frontier and trans log form of distance functions with identical second-order terms. These distance functions are graphically illustrated in Figure 1, as horizontal distance between points is equal to projection of those points on x-axis. For example, the distance of point e from y-axis can be interpreted as 0e. In this way, Malmquist index can be written as

$$M_o^{t+1}(y^{t+1},x^{t+1},y^t,x^t) = \sqrt{\left[\frac{0h/0j}{0c/0e} \times \frac{0f/0j}{0a/0e}\right]}$$

Productivity could be due to adoption of new technology or managing resources efficiently under existent technology. In the similar fashion, M_o^{t+1} productivity index can be further decomposed into Efficiency change (E) and technological change (T) as under

$$M_o^{t+1}(y^{t+1},x^{t+1},y^t,x^t) =$$

$$= \underbrace{\frac{D_o^{t+1}(y^{t+1},x^{t+1}|CRS)}{D_o^t(y^t,x^t|CRS)}}_{\Delta E} \times \underbrace{\sqrt{\frac{D_o^t(y^{t+1},x^{t+1}|CRS)}{D_o^{t+1}(y^{t+1},x^{t+1}|CRS)} \times \frac{D_o^t(y^t,x^t|CRS)}{D_{io}^{t+1}(y^t,x^t|CRS)}}}_{\Delta T}$$

This decomposition can be illustrated in Figure 1 as

$$M_o^{t+1}(y^{t+1},x^{t+1},y^t,x^t)=\underbrace{\frac{0a/0e}{0h/0j}}_{\Delta E}\times\underbrace{\sqrt{\frac{0c/0e}{0a/0e}\times\frac{0h/0j}{0f/0j}}}_{\Delta T}$$

The first ratio on left hand side (outside the brackets) represents efficiency change (ΔE) which is the ratio of current level of efficiency divided by the previous one. With efficiency change greater than one, it shows that the country is utilizing existing technology more adeptly as compared to previous year, and is catching up to the frontier.

The group of ratios under root represents technological change (ΔT) over the period t and $t+1$, which are the changes in technology frontier as compared to its previous period. It is the geometric mean of two ratios. First ratio measures current level of efficiency with respect to the previous period production technology, relative to the current level. The second ratio tells the previous level of efficiency with respect to the current technology frontier. A larger than one technological change means progressive shift in technology frontier and is attributed to one of the reasons for change in country's productivity. Factors influencing it are increased knowledge, innovations in technologies of management (improved production processes), finance (financial liberalization and development) and market technologies (deregulation and competition).

If constant return to scale (CRS) assumption is relaxed to incorporate variable return to scale (VRS) (Banker et al., 1984 DEA model), the efficiency change (ΔE) measure can be decomposed into change in pure efficiency (ΔP) and change in scale efficiency (ΔS) (Fare et al., 1994a). Mathematically we can express it as follows:

$$\text{Pure efficiency }(\Delta\text{P})=\frac{D_o^{t+1}(y^{t+1},x^{t+1}|VRS)}{D_o^t(y^t,x^t|VRS)}$$

$$Scaleefficiency\ (\Delta S)=$$

$$\left[\frac{D_o^{t+1}(0by^{t+1},0e\,x^{t+1}|VRS)}{D_o^{t+1}(0ay^{t+1},0ex^{t+1}|CRS)}\Big/\frac{D_o^{t+1}(0gy^t,0jx^t|VRS)}{D_o^{t+1}(0fy^t,0jx^t|CRS)}\right]\times\left[\frac{D_o^t(0dy^{t+1},0ex^{t+1}|VRS)}{D_o^t(0cy^{t+1},0ex^{t+1}|CRS)}\Big/\frac{D_o^t(0iy^t,0jx^t|VRS)}{D_o^t(0hy^t,0jx^t|CRS)}\right]$$

In this way productivity change is made up of pure efficiency, scale efficiency and technological change ($M_o^{t+1}=(\Delta P\times\Delta S)\times\Delta T$).

Change under CRS technology is ΔE which carries both efficiency and scale effects, whereas similar change under VRS technology is in pure efficiency ΔP, and scale efficiency ΔS shows the magnitude to change between CRS and VRS technologies in each period. It is the ratio of CRS efficiency scores to VRS ones and refers to exploiting economies of scale by operating closer to CRS frontier. Scale efficiency change score of one means that economy is operating at capacity where economies of scale are fully captured and production frontier depicts CRS. For graphical illustration in Figure 1, Malmquist productivity index is given as

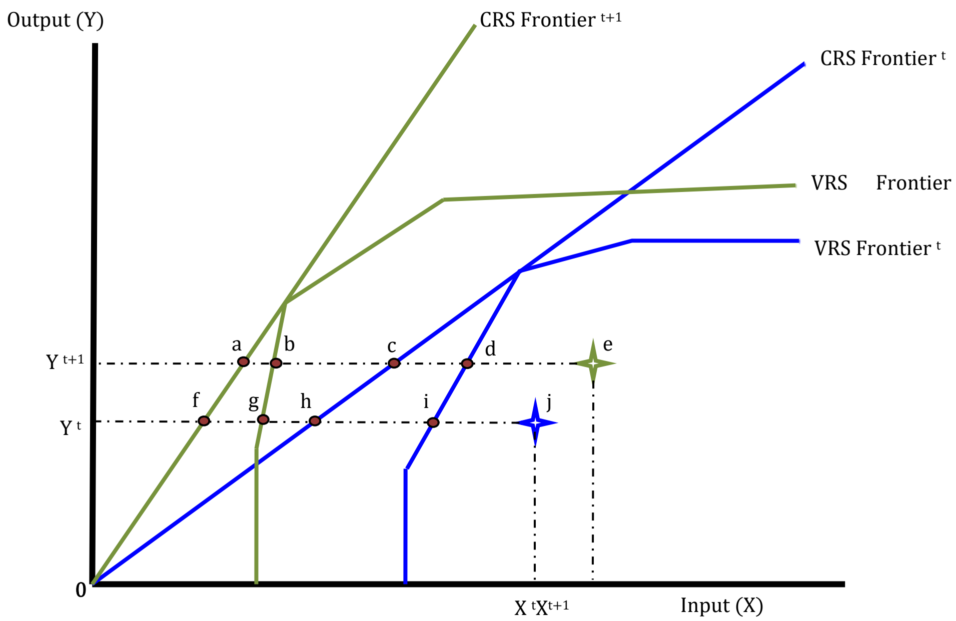
$$M_o^{t+1}(y^{t+1}, x^{t+1}, y^t, x^t) =$$

$$= \underbrace{\underbrace{\frac{0b/0e}{0h/0j}}_{\Delta P} \times \underbrace{\left[\frac{0b/0e}{0a/0e} \Big/ \frac{0g/0j}{0f/0j}\right] \times \left[\frac{0d/0e}{0c/0e} \Big/ \frac{0i/0j}{0h/0j}\right]}_{\Delta S}}_{\Delta E} \times \underbrace{\sqrt{\frac{0c/0e}{0a/0e} \times \frac{0h/0j}{0f/0j}}}_{\Delta T}$$

Radial distance functions used in productivity index are calculated through DEA linear programming (LP) methodology using Wilson's FEAR 2 software (2008).This frontier construction method used input and output quantities data points of countries in our sample to solve a series of LP problems, one for each country. To estimate distance functions, we used output oriented both CRS and VRS models.

Since DEA based approach calculating the Malmquist index has serious shortcomings as discussed before, we apply bootstrap procedure of Simar and Wilson (2000) to correct for the biasness and construct confidence interval to provide statistical inferences[(12)]. Hence the statistical significance of productivity, efficiency and technological changes was also tested. The bootstrap approach in the DEA context was first introduced by Simar and Wilson (1998) and was further developed by them in Simar and Wilson 2000).

Figure 1. *Malmquist Productivity Change using VRS and CRS technology with one input and output*



The bootstrap is a computer-based method that re samples the original data in order to assign statistical properties. It is based on the idea that the unknown distribution of the difference between the true and estimated score is approximated by the distribution of the difference between the estimated and the bootstrapped score. To illustrate, we follow the following steps:

(1) The Malmquist indices are first computed using output-oriented DEA model (as discussed previously).
(2) A pseudo data set is then generated using the bivariate kernel density estimator to construct the reference bootstrap technology.
(3) The bootstrap estimates of the Malmquist indices are then computed by applying the original estimators to the pseudo sample obtained in step (2). The bivariate smoothed bootstrap procedure of Simar and Wilson (2000) is used to correct for the temporal correlations between these scores in two time periods.
(4) Steps (2)–(3) are repeated 10,000 times to create a set of vector estimates.
(5) Bootstrap confidence intervals are then constructed using the percentile method for the Malmquist indices.

Bias-corrected estimates of the Malmquist indices are also obtained to improve the confidence interval as suggested by Simar and Wilson (2000). For Malmquist productivity index (Mo), the bias-corrected estimate is expressed as

$$\text{(Bias Corrected) Mo } = 2 \times \text{ Mo} - \frac{\sum_{n=1}^{10,000} \text{Bootstrap estimate of Mo}}{N}$$

Where

$$\text{Bias } = \frac{\sum_{n=1}^{10,000} \text{Bootstrap estimate of Mo}}{N} - \text{Mo}$$

The same procedure is also applied for all other Malmquist indices. A second bootstrap is also used in regression analysis to further improve the results.

In the second stage, we use the bias corrected Malmquist indices as the dependent variable (y_i) regressing them on potential exogenous (environmental) variables including institutions (x_i):

$$y_i = a + x_i \beta + ©_i$$

where $©_i$ is a statistical noise.

At first, Bias corrected Malmquist indices are regressed on their potential covariant. To overcome the problem of correlation of second stage environmental variables with inputs and outputs of productivity estimates, we performed a second (double) bootstrap on linear regression to re-estimate the marginal effects of the environmental variables. We obtain 10,000 replications for each parameter estimate. Bias corrected regression coefficients and Standard errors are thus created for the parameters following the same procedure as discussed above.

3. Input/output specification and data description in productivity analysis

In productivity analysis, output per worker is used as output, whereas Physical capital per worker and human capital per worker are taken as inputs. As confirmed by Maudos et al. (1999) on OECD sample, human capital is the biggest source of variation in productivity growth after technical progress. However, it is not included in many studies as a productive factor, hence TFP estimated in these cases might be biased. We took the values of physical and human capital per worker as inputs and output per worker as output from the data set developed by Baier et al. (2006).

This data set is more comprehensive than any other previously available data used in growth analysis. They used a perpetual inventory method of calculation of the stock of physical and human capital made up of enrolment rates, years of schooling and experience. This data set covers 145 countries and spans for about hundred years for few countries and is divided into 10 years intervals so that single observation covers the effects of 10 years. The time span is long enough to neutralize the impact of business cycle fluctuations from the data. Table 1 reports the summary statistics of input and output variables used in this analysis.

We included 78 countries from this data set in our analysis and used the last two observations for each country covering the period of 1990 and 2000. These countries are from all parts of the world and are evenly distributed. Region wise distribution is as follows. Region wise distribution is as follows. Africa 9, East Asia and Australia 11, Eastern Europe 12, Latin America 18, Middle East and North Africa 8, North America 2, South Asia 4, Western Europe 14.

Total number of observations included in our dataset would be 468. In Growth accounting literature Summers and Heston (1988) database is widely used to estimate the production function; however, the information on human capital is not included in that data set which is considered a major drawback. This information then would have to be taken separately from other databases like Barro and Lee (1993).

Table 1. *Summary Statistics of Input and Output variables*

	Input Variables				Output variable	
	Human Capital per Worker		Physical Capital per Worker		Income per Worker	
	2000	1990	2000	1990	2000	1990
Mean	5.505933	4.959734	29955.59	26161.26	15931.57	13531.3
Median	5.624855	5.227323	21327.7	17807.79	10637.72	9507.424
Maximum	7.620805	7.299808	83329.67	77606	47047.83	38854.14
Minimum	2.411952	2.219233	656.1504	128.0718	743.4831	1001.961
Std. Dev.	1.332949	1.254658	25019.51	22726.33	13278.2	10648.75
Skewness	-0.433125	-0.288717	0.737446	0.786006	0.772058	0.808043
Kurtosis	2.377278	2.129405	2.21345	2.226252	2.212441	2.31949

4. Productivity results and discussion

Table 2 reports the productivity score of 78 countries included in our sample. Scores of Malmquist productivity change index, its two components namely technological and efficiency change along with further decomposition of efficiency change into change in scale and pure efficiency are displayed. Productivity change and its components have shown a slight decline of 0.3% from 1990 to 2000; however, there was no change in productivity in bias corrected scores. The Value of Malmquist productivity index or its sub components if more than unity shows improvement and less than unity shows decline in performance.

Un-weighted average scores showed that countries experiencing most productivity growth were Romania, South Africa and Argentina of about 75%, 75% and 61% respectively whereas major decline in productivity was experienced in Bangladesh, Nigeria and Ukraine of about 60%, 51% and 47% respectively. Region with highest productivity growth was Western Europe with about 12% growth, followed by North America, East Asian and Australian, and Eastern Europe by 6%, 1.3% and 1% respectively. Largest decline in productivity was experienced by south Asia of about 26% growth followed by Middle East and North Africa (MENA) and Latin America with decline in productivity of about 7%, 8%, and 1.3% respectively.

However, un-weighted average of world sample showed improvement of efficiency by about 0.8%, while decline in technology adoption by about 1%. An improvement in efficiency depicts that on average, world is utilizing its existent resources and technology more adeptly as in previous periods. Largest increase in efficiency over time under constant return of scale is of Romania of 100%, followed by South Africa and China of about 76%, and 75% respectively. Eastern Europe and Latin America experience highest improvement in efficiency of about 7% and 5% respectively whereas South Asia followed by North America and MENA region witnessed the biggest efficiency decline of about 13%, 11% and 7% respectively. We can also witness signs of catch-up or convergence as majority of countries that experience high growth have efficiency scores lower than average.[(13)]

Technology index also shows a slight decline of about 1%, which does not mean a reduction in knowledge stocks. This index depicts the change in a country's production frontier over time relative to that country inputs, not the actual shift of technology frontier. A negative growth of technology change index of a country could be due to comparatively less investment in development or absorption of new technology in terms of new procedures, techniques and skills as well as in adoption of existing technologies by that country. Numeric values suggested that countries like Ireland, Germany, Spain and Netherland witnessed the highest growth in innovations and technological adoption of about 24%, 23%, 22% and 22% respectively as compared to previous period whereas Morocco, Zimbabwe and Kenya registered significant decline in technological investments of about 21% each. Region witnessing the highest growth in technology is North America followed by Western Europe of 18% and 14% respectively. Largest decline appeared in the South Asian region followed by Africa of about 14% and 12% respectively.

When applying VRS assumption, efficiency change is further decomposed into1) changes in scale operations, and 2) pure efficiency change.

While decomposing the change, we witnessed a large variation in its two sub components. Pure efficiency increased and scale efficiency declined by about 1.5%. Largest increase in pure efficiency was witnessed in China followed by El Salvador and South Africa of about

66%, 65%, and 63% respectively, whereas largest decline was noted in Ukraine and Russia of about 51% and 42% respectively. Africa and Latin American regions showed largest growth of about 16% and 7% respectively whereas largest decline was seen in MENA and Eastern European region of about 7% and 5% respectively. In case of scale efficiency, countries like Philippines, Sri Lanka, and Slovakia also experienced huge growth in scale operations of about 25%, 24%, and 23%. Eastern Europe showed the largest improvement in Scale operations of about 11%, whereas South Asia and Africa showed the largest decline of about 25%, and 20% respectively. When comparing bias and bias-corrected scores, the ranking of regions for all productivity indices remains stable even after the bias-correction.

5. Regression methodology

Calculation of Productivity indices in the above section was the first stage in two stage procedure. In the second stage the factors that influence these indices will be explored. These factors may be exogenous to the production model and therefore have not been included in inputs directly but have a huge indirect impact on the outcome. Institutions may be one of such factors. Hence, in the second stage, these factors are analyzed using regression analysis and the channels through which these factors impact productivity are identified.

In empirical literature, there is no specific approach to specify second stage regression equations. We thus used Malmquist productivity change index (MPC) and its components along with its efficiency change (EC) and technology change (TC) sub-indices as dependent variables. We used bias corrected values of these three indices. The Index of Institutional Social Technologies (IIST) and its three sub-indices Risk-reducing Technologies (SiiF1), Factor of Institutional and Policy Rents (RiiF2) and Factor of Political Rent (RpiF2) were used as explanatory variables for institutional characteristics. They variables have values ranges between 0 and 1 and higher values indicate better institutional quality. Other variables like Inflation and Trade Balance are also used as explanatory ones to control the different macroeconomic conditions. Higher inflation could possibly retard the productivity growth due to higher level of uncertainty and hence could have a negative expected sign. Trade balance as percentage of GDP is used to measure the country dependence on international resources. A high level of trade increases output and may have positive impact on productivity. Inflation is measured as the ratio of GDP in current local currency to GDP in constant local currency. The base year varies by country whereas Trade is measured as percentage of GDP. These variables are taken from World Development Indicators WDI (2008) and are expressed in terms of averages from the year 1990 to 2000 depending on the availability of data. Table 3 provided their descriptive statistics. These explanatory variables are used in all equations to access their influences on productivity and their components.

Table 2. *Bootstrap Malmquist Productivity Index and its Decomposition*

					Decomposition of Malmquist Productivity Change (MPC)								Decomposition of Efficiency Change							
Countries	Productivity Change (MPC)				Efficiency Change (EC)				Technological Change (TC)				Pure Efficiency Change (PEC)				Scale Efficiecy Change (SEC)			
		MPC_bc (Baised Corr.)	95% confidence Interval			EC_bc (Baised Corr.)	95% confidence Interval			TC_bc (Baised Corr.)	95% confidence Interval			PEC_bc (Baised Corr.)	95% confidence Interval			SEC_bc (Baised Corr.)	95% confidence Interval	
	MPC		Low	High	EC		Low	High	TC		Low	High	PEC		Low	High	SEC		Low	High
Algeria	0.9285	0.9343	0.9244	0.9482	0.8879	0.9111	0.8412	0.9782	1.0457	1.0227	0.9350	1.1054	0.8376	0.8472	0.7815	0.9087	1.0601	1.0750	0.9917	1.1490
Argentina	1.6116	1.6142	1.6032	1.6281	1.5841	1.6133	1.5003	1.7254	1.0173	0.9985	0.9211	1.0695	1.5780	1.6081	1.4732	1.7369	1.0039	1.0027	0.9597	1.0401
Australia	0.9534	0.9627	0.9243	0.9811	0.8375	0.8461	0.7246	0.9585	1.1384	1.1328	0.9753	1.2741	0.8443	0.8535	0.7284	0.9680	0.9920	0.9909	0.9409	1.0478
Austria	1.2317	1.2230	1.2022	1.2655	1.0765	1.0653	0.9153	1.1955	1.1442	1.1435	0.9859	1.2856	1.0829	1.0701	0.9145	1.2046	0.9941	0.9949	0.9459	1.0750
Bangladesh	0.3929	0.4060	0.3575	0.4256	0.4795	0.4114	0.0906	0.6241	0.8194	0.9042	0.5219	1.1846	0.8999	1.1054	0.7227	1.5065	0.5329	0.2217	-0.5784	0.5693
Belgium	1.1400	1.1359	1.1077	1.1802	0.9856	0.9699	0.8326	1.0873	1.1566	1.1664	1.0120	1.3068	1.0000	0.9876	0.8444	1.1159	0.9856	0.9814	0.9365	1.0607
Bolivia	0.7919	0.7748	0.7502	0.7904	0.9691	0.9286	0.7469	1.0827	0.8172	0.8275	0.6907	0.9505	0.9922	0.9639	0.7986	1.1053	0.9767	0.9644	0.9135	1.0305
Botswana	1.3537	1.3552	1.3516	1.3598	1.4607	1.4678	1.3506	1.5837	0.9268	0.9217	0.8435	0.9931	1.4702	1.5267	1.4019	1.6538	0.9935	0.9575	0.8632	1.0490
Brazil	0.9735	0.9735	0.9717	0.9752	0.9905	1.0038	0.9381	1.0705	0.9828	0.9683	0.8965	1.0323	0.9989	1.0122	0.9427	1.0830	0.9916	0.9912	0.9351	1.0453
Bulgaria	0.6963	0.7032	0.6846	0.7256	0.6817	0.7004	0.6496	0.7501	1.0214	1.0016	0.9250	1.0719	0.6859	0.7122	0.6461	0.7731	0.9939	0.9818	0.9332	1.0260
Canada	1.0199	1.0261	1.0103	1.0494	0.8624	0.8450	0.7325	0.9452	1.1826	1.2089	1.0628	1.3462	0.8951	0.8951	0.7596	1.0161	0.9635	0.9423	0.8613	1.0273
Chile	0.9032	0.9032	0.8863	0.9197	0.9155	0.9280	0.8659	0.9905	0.9866	0.9717	0.8999	1.0355	0.8741	0.8696	0.8066	0.9314	1.0473	1.0668	1.0191	1.1072
China	1.2961	1.4608	1.3211	1.6262	1.5841	1.7501	1.4778	2.0305	0.8182	0.8333	0.6887	0.9639	1.5479	1.6567	1.4514	1.9295	1.0234	1.0616	0.9694	1.1393
Colombia	0.9357	0.9410	0.9318	0.9531	1.0242	1.0314	0.9442	1.1190	0.9136	0.9107	0.8275	0.9857	1.0670	1.0973	1.0111	1.1917	0.9599	0.9385	0.8929	0.9845
Costa Rica	1.2778	1.2774	1.2710	1.2831	1.2852	1.3036	1.2166	1.3901	0.9942	0.9783	0.9055	1.0442	1.3196	1.3433	1.2451	1.4358	0.9739	0.9699	0.9302	1.0174
Czech Republic	1.3083	1.3212	1.2702	1.3764	1.3663	1.3913	1.2885	1.5021	0.9576	0.9481	0.8764	1.0129	1.2088	1.1936	1.1029	1.2763	1.1302	1.1644	1.0997	1.2416
Denmark	1.1929	1.1942	1.1708	1.2074	1.0602	1.0731	0.9405	1.1847	1.1252	1.1089	0.9800	1.2331	1.0715	1.0942	0.9412	1.2215	0.9894	0.9794	0.9220	1.0423
Dominican Rep.	1.1268	1.1210	1.1034	1.1348	1.2074	1.2072	1.1095	1.2997	0.9333	0.9271	0.8509	0.9963	1.2313	1.2428	1.1537	1.3285	0.9806	0.9711	0.9321	1.0143
Ecuador	0.6338	0.6265	0.6107	0.6386	0.6915	0.6853	0.6215	0.7435	0.9165	0.9125	0.8312	0.9857	0.6765	0.6675	0.6095	0.7172	1.0223	1.0265	0.9809	1.0728
Egypt	1.0783	1.0628	1.0447	1.0847	1.2471	0.9687	0.1821	1.5457	0.8647	0.9719	0.5866	1.2510	1.1964	0.8829	0.0256	1.4692	1.0424	1.0708	0.9530	1.1669
El Salvador	1.2305	1.2485	1.2312	1.2736	1.4472	1.4547	1.2629	1.6354	0.8502	0.8548	0.7411	0.9593	1.5911	1.6548	1.4835	1.8349	0.9096	0.8760	0.7973	0.9533
Estonia	0.9170	0.9177	0.8950	0.9402	0.9345	0.9471	0.8834	1.0127	0.9813	0.9675	0.8962	1.0306	0.8560	0.8518	0.7860	0.9147	1.0917	1.1111	1.0472	1.1770
Finland	1.0217	1.0199	0.9912	1.0483	0.8645	0.8384	0.7187	0.9485	1.1818	1.2101	1.0610	1.3476	0.9008	0.8945	0.7530	1.0207	0.9597	0.9359	0.8569	1.0346
France	0.9040	0.9188	0.8762	0.9386	0.8020	0.8228	0.7056	0.9303	1.1272	1.1110	0.9530	1.2528	0.8277	0.8675	0.7439	0.9782	0.9689	0.9457	0.8808	1.0339
Germany	1.0540	1.0502	1.0326	1.0675	0.8829	0.8469	0.7199	0.9625	1.1937	1.2317	1.0766	1.3736	0.9047	0.8787	0.7461	0.9977	0.9760	0.9639	0.9127	1.0379
Greece	1.2494	1.2405	1.2210	1.2534	1.1793	1.1975	1.0903	1.2932	1.0594	1.0331	0.9397	1.1221	1.1771	1.2083	1.0858	1.3179	1.0018	0.9899	0.9448	1.0279
Guatemala	0.9183	0.9171	0.9145	0.9191	1.0007	1.0014	0.9156	1.0839	0.9177	0.9142	0.8330	0.9883	1.0000	1.0939	0.9163	1.2337	1.0007	0.8895	0.6723	1.0918
Honduras	0.6822	0.6944	0.6758	0.7177	0.7477	0.7628	0.7020	0.8295	0.9123	0.9086	0.8263	0.9827	0.8021	0.8123	0.7379	0.8944	0.9323	0.9382	0.8630	1.0047
Hungary	1.0524	1.0565	1.0075	1.1062	1.0799	1.0953	1.0080	1.1837	0.9744	0.9631	0.8924	1.0276	0.9460	0.9273	0.8543	0.9956	1.1416	1.1794	1.1151	1.2551
India	0.9650	1.0109	0.9693	1.0728	1.2105	1.2355	1.0008	1.4513	0.7972	0.8120	0.6545	0.9521	1.3055	1.3737	1.1639	1.5865	0.9272	0.8960	0.8156	0.9831

					Decomposition of Malmquist Productivity Change (MPC)								Decomposition of Efficiency Change							
	Productivity Change (MPC)				Efficiency Change (EC)				Technological Change (TC)				Pure Efficiency Change (PEC)				Scale Efficiecy Change (SEC)			
			95% confidence Interval				95% confidence Interval				95% confidence Interval				95% confidence Interval				95% confidence Interval	
Countries	MPC	MPC_bc (Baised Corr.)	Low	High	EC	EC_bc (Baised Corr.)	Low	High	TC	TC_bc (Baised Corr.)	Low	High	PEC	PEC_bc (Baised Corr.)	Low	High	SEC	SEC_bc (Baised Corr.)	Low	High
Indonesia	0.6549	0.6658	0.6524	0.6843	0.7398	0.7502	0.6771	0.8252	0.8852	0.8852	0.7896	0.9707	0.7862	0.8174	0.7453	0.8961	0.9411	0.9153	0.8529	0.9758
Ireland	1.4966	1.4930	1.4851	1.4995	1.2454	1.1909	1.0126	1.3508	1.2017	1.2445	1.0890	1.3876	1.2033	1.1017	0.9242	1.2830	1.0350	1.0728	1.0084	1.1464
Israel	1.1616	1.1573	1.1226	1.1767	1.0419	1.0538	0.9269	1.1598	1.1150	1.0945	0.9730	1.2133	1.0005	0.9655	0.8378	1.0814	1.0413	1.0876	1.0389	1.1412
Italy	0.9813	0.9840	0.9650	0.9935	0.8471	0.8375	0.7170	0.9476	1.1584	1.1697	1.0134	1.3113	0.8540	0.8452	0.7251	0.9562	0.9920	0.9905	0.9419	1.0551
Jamaica	0.6356	0.6418	0.6341	0.6526	0.7171	0.7225	0.6510	0.7940	0.8863	0.8861	0.7904	0.9713	0.6342	0.6144	0.5532	0.6667	1.1308	1.1730	1.1122	1.2528
Japan	1.0725	1.0587	1.0225	1.1180	0.9415	0.9312	0.8018	1.0422	1.1391	1.1329	0.9791	1.2722	0.9586	0.9699	0.8244	1.1027	0.9822	0.9582	0.8850	1.0411
Jordan	0.6195	0.6176	0.6078	0.6255	0.6104	0.6186	0.5743	0.6611	1.0149	0.9965	0.9206	1.0663	0.6156	0.6009	0.5361	0.6581	0.9916	1.0262	0.9369	1.1075
Kenya	0.7009	0.6609	0.6004	0.7099	0.9246	0.7891	0.3186	1.1334	0.7580	0.7922	0.5179	1.0158	1.1739	1.1458	0.7506	1.4486	0.7877	0.6962	0.5308	0.8487
Korea, South	0.9155	0.8943	0.8491	0.9285	0.8775	0.8765	0.7892	0.9479	1.0433	1.0187	0.9342	1.0973	0.8404	0.8316	0.7428	0.9088	1.0441	1.0533	0.9975	1.1004
Latvia	0.8705	0.8680	0.8510	0.8836	0.9005	0.9075	0.8421	0.9703	0.9667	0.9550	0.8842	1.0180	0.8495	0.8392	0.7659	0.9104	1.0601	1.0803	1.0201	1.1353
Lithuania	0.8931	0.8963	0.8852	0.9092	0.9387	0.9500	0.8846	1.0183	0.9514	0.9420	0.8698	1.0070	0.8473	0.8361	0.7705	0.8985	1.1079	1.1348	1.0689	1.2057
Malawi	0.6576	0.6374	0.6044	0.6727	0.7833	0.6143	0.1039	0.9736	0.8395	0.9283	0.5671	1.1983	0.9581	1.0340	0.7419	1.2633	0.8176	0.5390	-0.0932	0.9951
Malaysia	0.8052	0.8032	0.7987	0.8060	0.7469	0.7647	0.6906	0.8293	1.0782	1.0465	0.9419	1.1494	0.6736	0.6494	0.5517	0.7462	1.1088	1.1685	1.0109	1.3039
Mexico	0.8051	0.8208	0.8008	0.8495	0.7511	0.7831	0.7148	0.8465	1.0719	1.0439	0.9454	1.1404	0.6778	0.6840	0.6262	0.7415	1.1080	1.1447	1.0400	1.2264
Morocco	0.6466	0.7425	0.6627	0.8315	0.8353	0.9367	0.7199	1.1101	0.7740	0.7876	0.5925	0.9617	1.0000	1.1711	0.9202	1.3686	0.8353	0.7822	0.6505	0.8878
Namibia	1.1557	1.1660	1.1191	1.2159	1.1526	1.1804	1.0888	1.2682	1.0027	0.9858	0.9140	1.0513	0.8772	1.1092	0.8565	1.3130	1.3140	0.8154	0.0577	1.3883
Netherlands	1.1325	1.1301	1.1045	1.1500	0.9531	0.9203	0.7862	1.0388	1.1882	1.2208	1.0710	1.3603	1.0032	0.9893	0.8294	1.1282	0.9501	0.9288	0.8381	1.0443
New Zealand	0.9914	0.9963	0.9500	1.0592	0.8747	0.8794	0.7821	0.9784	1.1335	1.1302	1.0072	1.2465	0.8948	0.9116	0.7981	1.0240	0.9776	0.9633	0.9085	1.0203
Nicaragua	0.8964	0.7907	0.6507	0.8857	1.0710	0.9216	0.6474	1.1303	0.8370	0.8477	0.7223	0.9640	1.1850	1.0894	0.8702	1.2460	0.9038	0.8555	0.7739	0.9591
Nigeria	0.4947	0.4922	0.4887	0.4944	0.6363	0.6084	0.4414	0.7459	0.7774	0.7959	0.6112	0.9552	0.7337	0.7815	0.6524	0.8981	0.8673	0.7595	0.4727	0.9964
Norway	1.1796	1.1729	1.1689	1.1859	1.0686	1.0900	0.9375	1.2247	1.1039	1.0696	0.9052	1.2195	1.0766	1.0967	0.9298	1.2404	0.9926	0.9931	0.9396	1.0722
Pakistan	0.6591	0.6640	0.6580	0.6725	0.7526	0.7554	0.6737	0.8360	0.8757	0.8764	0.7743	0.9671	0.7888	0.9562	0.6689	1.2032	0.9541	0.6296	-0.1153	1.1006
Panama	0.9711	0.9718	0.9679	0.9761	1.0092	1.0204	0.9526	1.0903	0.9622	0.9509	0.8795	1.0145	0.9659	0.9635	0.8973	1.0291	1.0448	1.0588	1.0092	1.1037
Paraguay	1.3409	1.3539	1.3262	1.3875	1.4428	1.4630	1.3524	1.5813	0.9294	0.9239	0.8470	0.9935	1.5321	1.5536	1.4246	1.6942	0.9417	0.9410	0.8788	0.9992
Peru	1.3302	1.3289	1.3253	1.3317	1.4408	1.4437	1.3240	1.5584	0.9233	0.9189	0.8397	0.9917	1.3515	1.3297	1.2210	1.4259	1.0661	1.0850	1.0333	1.1387
Philippines	1.3519	1.3618	1.3523	1.3759	1.5823	1.5817	1.3746	1.7739	0.8544	0.8575	0.7446	0.9593	1.3402	1.2534	1.0772	1.4029	1.1806	1.2515	1.1791	1.3443
Poland	1.2117	1.2100	1.1992	1.2199	1.2573	1.2689	1.1817	1.3554	0.9637	0.9522	0.8811	1.0157	1.1839	1.1762	1.0789	1.2718	1.0620	1.0779	1.0147	1.1403
Portugal	1.0663	1.0514	1.0199	1.0726	1.0040	1.0136	0.9158	1.0980	1.0620	1.0348	0.9401	1.1253	0.9957	0.9987	0.8990	1.0872	1.0083	1.0147	0.9864	1.0443

					Decomposition of Malmquist Productivity Change (MPC)								Decomposition of Efficiency Change							
Countries	Productivity Change (MPC)				Efficiency Change (EC)				Technological Change (TC)				Pure Efficiency Change (PEC)				Scale Efficiecy Change (SEC)			
		MPC_bc (Baised Corr.)	95% confidence Interval			EC_bc (Baised Corr.)	95% confidence Interval			TC_bc (Baised Corr.)	95% confidence Interval			PEC_bc (Baised Corr.)	95% confidence Interval			SEC_bc (Baised Corr.)	95% confidence Interval	
	MPC		Low	High	EC		Low	High	TC		Low	High	PEC		Low	High	SEC		Low	High
Romania	1.7628	1.7542	1.7389	1.7646	2.0206	2.0019	1.7645	2.2262	0.8724	0.8733	0.7693	0.9656	1.7417	1.6239	1.4106	1.8091	1.1602	1.2230	1.1528	1.3097
Russia	0.6033	0.6010	0.5945	0.6057	0.5812	0.5899	0.5432	0.6333	1.0380	1.0166	0.9312	1.0961	0.5691	0.5821	0.5263	0.6334	1.0212	1.0122	0.9541	1.0710
Singapore	1.3719	1.3562	1.3399	1.4003	1.2368	1.2512	1.0794	1.4024	1.1092	1.0784	0.9171	1.2257	1.2092	1.1279	0.9093	1.3335	1.0228	1.0953	0.9570	1.1956
Slovakia	1.3721	1.4046	1.3488	1.4705	1.4817	1.5239	1.4071	1.6560	0.9261	0.9200	0.8425	0.9898	1.2595	1.2353	1.1422	1.3243	1.1764	1.2311	1.1636	1.3182
South Africa	1.7391	1.7517	1.7051	1.8054	1.7157	1.7566	1.6296	1.8812	1.0136	0.9951	0.9201	1.0630	1.5839	1.6352	1.5161	1.7565	1.0832	1.0725	0.9713	1.1616
Spain	1.0036	0.9981	0.9763	1.0134	0.8439	0.8122	0.6932	0.9185	1.1891	1.2215	1.0730	1.3596	0.8052	0.7366	0.6186	0.8565	1.0482	1.0930	1.0235	1.1695
Sri Lanka	0.8790	0.9010	0.8811	0.9295	1.0489	1.0621	0.9157	1.2005	0.8380	0.8446	0.7244	0.9533	0.8918	0.8546	0.7371	0.9528	1.1761	1.2375	1.1652	1.3322
Sweden	1.0006	1.0026	0.9952	1.0146	0.8565	0.8447	0.7353	0.9418	1.1682	1.1824	1.0408	1.3162	0.8464	0.8239	0.7134	0.9250	1.0120	1.0243	0.9877	1.0610
Switzerland	1.2089	1.2095	1.2089	1.2152	1.1153	1.1631	1.0000	1.3040	1.0840	1.0302	0.8640	1.1857	1.0466	1.0354	0.8644	1.1872	1.0657	1.1206	1.0379	1.2078
Taiwan	0.8916	0.8738	0.8379	0.8995	0.8430	0.8455	0.7609	0.9168	1.0576	1.0315	0.9402	1.1181	0.8481	0.8473	0.7552	0.9290	0.9939	0.9974	0.9590	1.0432
Tanzania	0.7209	0.7164	0.7093	0.7395	0.8772	0.7035	0.1169	1.1136	0.8219	0.9086	0.5027	1.2059	1.0000	0.9327	0.1352	1.4196	0.8772	0.6830	-0.3326	1.2882
Thailand	0.7394	0.7449	0.7224	0.7695	0.7726	0.7850	0.7300	0.8447	0.9571	0.9474	0.8762	1.0115	0.7962	0.8081	0.7423	0.8776	0.9703	0.9708	0.9160	1.0242
Tunisia	1.0138	1.0095	0.9951	1.0215	1.0771	1.0796	0.9963	1.1594	0.9413	0.9337	0.8602	1.0010	1.0947	1.1079	1.0290	1.1922	0.9839	0.9739	0.9204	1.0216
Turkey	0.8606	0.8658	0.8475	0.8868	0.9045	0.9174	0.8542	0.9856	0.9515	0.9423	0.8707	1.0069	0.9297	0.9463	0.8741	1.0241	0.9729	0.9687	0.9136	1.0203
Ukraine	0.5278	0.5304	0.5238	0.5386	0.5644	0.5703	0.5276	0.6142	0.9351	0.9286	0.8530	0.9975	0.4940	0.4859	0.4460	0.5230	1.1424	1.1720	1.0968	1.2515
United Kingdom	1.0330	1.0328	1.0312	1.0357	0.9238	0.9376	0.8302	1.0317	1.1182	1.0976	0.9703	1.2216	0.9138	0.9183	0.8040	1.0206	1.0110	1.0207	0.9817	1.0611
United States	1.0945	1.0885	1.0330	1.1245	0.9533	0.9418	0.8072	1.0559	1.1481	1.1516	1.0190	1.2766	1.0000	1.0306	0.8653	1.1613	0.9533	0.9091	0.8171	1.0250
Venezuela	0.7395	0.7604	0.7221	0.8091	0.6591	0.6713	0.6139	0.7376	1.1219	1.1312	1.0262	1.2295	0.5959	0.6284	0.5548	0.6967	1.1061	1.0604	0.9093	1.2029
Zambia	0.6349	0.5663	0.4745	0.6266	0.8001	0.6827	0.4351	0.8791	0.7935	0.8115	0.6469	0.9563	1.0857	1.1227	0.9566	1.2626	0.7370	0.5973	0.3874	0.7780
Zimbabwe	1.0229	1.0451	1.0251	1.0746	1.3346	1.3038	0.9310	1.6072	0.7665	0.7879	0.5891	0.9595	1.2782	1.2086	0.8977	1.4757	1.0442	1.0764	0.9808	1.1632
Average	0.9969	0.9992			1.0141	1.0080			0.9885	0.9896			1.0100	1.0154			1.0048	0.9848		

Bias Corrected Values and Confidence Interval are obtained from 10,000 bootstrap replications.

Table 3. *Descriptive Statistics*

	Mean	Max	Min	Std. Dev.	Skewness	Kurtosis	Obs.
MPC_bc	0.9992	1.7542	0.4060	0.2834	0.3830	3.0294	78
EC_bc	1.0080	2.0019	0.4114	0.3042	0.9352	3.8114	78
TC_bc	0.9896	1.2445	0.7876	0.1208	0.3722	2.2955	78
IIST	0.5850	0.8120	0.3560	0.1290	0.2060	1.8930	84
SiiF1	0.5890	1	0	0.2160	-0.5740	2.9260	84
RpiF2	0.4670	1	0	0.2090	0.0780	2.7300	84
RiiF3	0.7120	1	0	0.2480	-1.2990	3.4070	84
TRADEBAL	-0.0269	0.139	-0.244	0.069	-0.527	4.017	83
INFLATION	461.9332	25107.73	9.270849	2751.879	8.814013	79.41708	83

Table 4. *Correlation coefficient matrix*

	MPC_bc	EC_bc	TC_bc	INFLATION	TRADEBAL	RpiF3	RiiF2	SiiF1	IIST
MPC_bc	1								
EC_bc	0.9149	1							
TC_bc	0.2289	-0.1677	1						
INFLATION	-0.0704	-0.0439	-0.0632	1					
TRADEBAL	0.2147	0.0294	0.4704	0.0023	1				
RpiF3	0.2004	0.0581	0.4156	0.0347	0.0775	1			
RiiF2	0.3145	0.1275	0.4694	0.1306	0.4207	0	1		
SiiF1	0.1929	-0.0035	0.4542	-0.2854	0.1087	0	0	1	
IIST	0.4086	0.1028	0.7783	-0.0795	0.3448	0.5687	0.556	0.5933	1

6. Results

Table 4 provides information about their correlations coefficient. Efficiency change is more closely related to productivity change whereas negatively correlated with the technological change. Table 4 also shows that Institutional indices are orthogonal (zero correlation among them), and have positive correlation with productivity indices particularly with technological change index which indicates that quality of institutions does produce a considerable positive influence on workers' productivities. Inflation is negatively correlated with other variables as expected. However, it is slightly positively correlated with some institutions and trade balance. The correlation coefficients of trade balance are positive for all variables as expected.

Results are given in Tables 5.1, 5.2 and 5.3. Columns 2 and 4 of Table 5.1 give biased corrected results from OLS method. Column 2 has combined index for institutions and column 4 gives the results when three separate indices of institutions are used. Columns 3 and 5 of Table 5.1 give biased corrected results using Bootstrap regression. Colum 3 used combined index of institution and Column 5 used three indices for three types of institutions. All equations have inflation and trade balances as other independent variables to capture the impact of macroeconomic effects on productivity, efficiency and technology.

Regression analysis in Columns 2 and 3 of Table 5.1 both show the impact of aggregate index of institutions on productivity change. This Table 5.1 shows either we use OLS and Bootstrap regression, the results are robust and show a very significant positive impact of institutions on productivity. The other variables that supposed to capture the impact of macro-economic conditions on productivity have expected sign but insignificant. Inflation retards productivity and volume of trade enhances productivity as theory suggests. Column 4 and 5 give the impact of three sets of institutions namely, Risk-reducing Technologies

(SiiF1) refers to institutions that reduce the cost of protecting property rights and strengthen contract enforcement. These services include provision of public goods such as rule of law and justice. The Second factor named Factor of Institutional and Policy Rents (RiiF2), focuses on technologies that help to eliminate or minimize two kinds of rent – institutional and policy rents. Third factor named Factor of Political Rent (RpiF3) measure the extent of power granted by institutions to political authorities. Among the three types of institutions, Factor of institutional and policy rents (RiiF2) seems to have a more significant impact on Productivity change indices as compared to other two as shown by their coefficient and significance values. This shows that institutions that curb corruption, bureaucratic inefficiencies, lax regulations and unfriendly business policies have more pronounced effect on productivity, as compared to those indices that curb political rents. Surprisingly institutions like law and order that reduce transactional risks seem to have no significant impact on productivity growth.

After discussing the impact of aggregate and individual indices of institutions on productivity growth, now we discuss the impact of these institutions on the components of productivity growth i.e. efficiency growth and technology growth. First we discuss effects on efficiency growth. Table 5.2 gives the effects of institutions and macroeconomic conditions on efficiency change. The results show all variables in each equation of this Table 5.2 whether estimated through OLS or Bootstrap give same results and all variables despite having correct signs are insignificant. Similarly, the macroeconomic variables are also insignificant.

Table 5.3 discusses the impact of these variables on technology change and unlike efficiency change all variables except inflation are significant and have correct sign. This indicates that institutions influence productivity mainly by increasing the pace of technological change. When institutions are strong, entrepreneurial resources, efforts and innovations are diverted from predatory activities towards production. Moreover, if Institutions that curb institutional and policy rents in the economies (RiiF2) are strong, it will lead to more efficient utilization of existent resources and technology. Overall, these findings prove positive relationship between institutions and productivity growth. Their estimates are large showing that marginal improvement in institutional qualities would produce huge impact on workers' productivity.

7. Conclusion

This paper analyze the role of different kinds of institutions in enhancing workers' productivity and efficiencies across countries in a two stage analysis. In the first stage, productivity growth and its components (technological and efficiency change) are calculated for 78 countries covering the period of 1990-2000 using a non-parametric method developed by Fare et al. (1985, 1994) and based on data envelopment analysis (DEA) as well as Malmquist index methodology. Apart from physical capital, this study also included human capital per worker as additional input. These estimates were improved adding stochastic elements and using bootstrap procedure as proposed by Simar and Wilson (2000).

Other factors such as institutions that are not included in Productivity Model are analyzed separately in the second stage by Regression Analysis where biased corrected productivity estimates on institutions and other macroeconomic variables are used. To further improve the result, the second (double) bootstrap is performed on the above regression, thus producing bias correct regression coefficients and standard errors.

For measuring quality of institutions, we had taken Institutions variables from Siddiqui and Ahmed (2013b). They are classified into three distinct dimensions namely institutional and policy rents, political rents and risk reducing technologies. The results suggest that across countries, workers ‘productivity remained constant during the period of study; however, technology adoption shows a slight decline during the period.

Findings from second stage of regression analysis suggest a strong and positive role of institutions in enhancing productivity growth of workers and show that institutions that curb corruption, bureaucratic inefficiencies and unfriendly business policies have more pronounced effect on productivity, as compared to those that pertain to law and order, justice and property rights enforcement and that curb political rents. Moreover, institutions influence productivity mainly through increasing the pace of technological change. When institutions are strong, entrepreneurial resources, efforts and innovations are diverted from predatory activities towards production. Furthermore, strong Institutions that curb institutional and policy rents in the economies (RiiF2) will also lead to more efficient utilization of existent resources and technology. However, the impact of institutions on productivity growth through the channel of increased workers' efficiency is still not conclusive. Overall, these results suggest that institutional reforms might play a pivotal role in productivity growth and technological changes.

Table 5. *The Determinants of Productivity Growth (Second Stage Bootstrapped regression), 1990-00*

5.1. *Dependent Variables: Bias-corrected Malmquist Productivity Change (MPC_bc)*

	OLS	Bootstrap LS	OLS	Bootstrap LS
IIST	0.8315	0.8315		
	0.0010	*0.0010*		
SiiF1			0.2211	0.2211
			0.063	*0.075*
RiiF2			0.4054	0.4054
			0.013	*0.011*
RpiF3			0.2372	0.2372
			0.114	*0.087*
INFLATION	-4.1E-06	-4.1E-06	-6.8E-06	-6.8E-06
	0.927	*0.968*	*0.871*	*0.949*
TRADEBAL	0.3629	0.3629	0.2299	0.2299
	0.458	*0.451*	*0.66*	*0.644*
Constant	0.5187	0.5187	0.5150	0.5150
	0.0020	*0.0020*	*0.003*	*0.003*
F (Prob.)	*0.0003*		*0.0017*	
R Square	0.1748	0.1748	0.1848	0.1848
chi-Sq (Prob.)		*0.0001*		*0.0005*

5.2. *Dependent Variables: Bias-corrected Efficiency Change (EC_bc)*

	OLS	Bootstrap LS	OLS	Bootstrap LS
IIST	0.2417	0.2417		
	0.4	*0.412*		
SiiF1			-0.0265	-0.0265
			0.849	*0.858*
RiiF2			0.2214	0.2214
			0.239	*0.247*
RpiF3			0.0796	0.0796
			0.668	*0.647*
INFLATION	-3.8E-06	-3.8E-06	-7.7E-06	-7.7E-06
	0.957	*0.977*	*0.91*	*0.955*
TRADEBAL	-0.0259	-0.0259	-0.1724	-0.1724
	0.966	*0.966*	*0.793*	*0.784*
Constant	0.8684	0.8684	0.8633	0.8633
	0.0000	*0.0000*	*0.0000*	*0.0000*
F (Prob.)	*0.8003*		*0.8615*	
R Square	0.0119	0.0119	0.0253	0.0253
chi-Sq (Prob.)		*0.8021*		*0.8764*

5.3. *Dependent Variables: Technological Change (TC)*

	TC_bc (Bias-corrected)		TC_bc (Bias-corrected)	
	OLS	Bootstrap LS	OLS	Bootstrap LS
IIST	0.6590	0.6590		
	0.0000	*0.0000*		
SiiF1			0.2405	0.2405
			0.0000	*0.0000*
RiiF2			0.2129	0.2129
			0.0000	*0.0000*
RpiF3			0.2030	0.2030
			0.0000	*0.0000*
INFLATION	-3.50E-07	-3.50E-07	-8.53E-08	-8.53E-08
	0.983	*0.991*	*0.996*	*0.998*
TRADEBAL	0.4169	0.4169	0.4277	0.4277
	0.024	*0.015*	*0.046*	*0.025*
Constant	0.6083	0.6083	0.6086	0.6086
	0.0000	*0.0000*	*0.0000*	*0.0000*
F (Prob.)	*0.0000*	*0.0000*	*0.0000*	
R Square	0.6522	0.6522	0.6526	*0.6526*
chi-Sq (Prob.)		*0.0000*		*0.0000*

Bias-adjusted coefficients and their Confidence intervals obtained from 10,000 bootstraping interactions.
Values in italics are P-values of t-statistics.
Values in parentheses are 95% Confidence Interval.
Standard errors are robust to Heteroscedasticity.
*Breusch-Pagan (1979) and Cook-Weisberg (1983) test for heteroskedasticity with null hypothesis of constant variance.

Notes

(1) They applied two stage Double Bootstrap DEA based nonparametric frontier analysis as proposed by Simar and Wilson (2007).
(2) There is a dearth of literature both theoretical and empirical, on the two stage procedure See Simar and Wilson (2007) for survey of two-stage procedure for analysis on determinants of DEA scores.
(3) First developed by Charnes, C. and Rhodes (CCR)(1978) with constant returns to scale assumptions. However it was later refined by Banker, Charnes, and Cooper (BCC) (1984) accommodating variable returns to scale in their analysis. See Berger and Humphrey (1997) for a detailed survey.
(4) See Hall and Jones (1999) for example.
(5) See Siddiqui and Ahmed (1013b) for details.
(6) See Aigner et al. (1977) for efficiency measurement using this technique.
(7) See Berger and Humphrey (1997) for a detailed survey.
(8) See (Fare et al., 1994; Chang and Luh, 1999; Kumar and Russell, 2002; Henderson and Russell, 2005; Arestis et al., 2006; Growiec, 2008; Maudos et al., 2000; Taskin and Zaim, 1997; Mathur, 2007; Milner and Weyman-Jones, 2003; Jerzmanowski, 2007; Dimelis and Dimopoulou, 2002; Deliktas and Balcilar, 2002), for example.
(9) They follow the same approach as used in Siddiqui and Ahmed (2013a) who also explained how institutions influence economic growth in a theoretical framework proposed by North (1981),
(10) See Siddiqui and Ahmed (2013a) for a detailed discussion.
(11) See (Färe et al., 1997; Førsund, 1997; Balk, 1997; Coelli et al., 1999) for theoretical groundwork for analysis of productivity indices.
(12) For a detailed description of the bootstrap procedure, see Simar and Wilson (2000).
(13) See Siddiqui and Ahmed (2013b) for details.

References

Abramovitz, M., 1956. Resource and Output Trends in the United States since 1870. *American Economic Review Papers and Proceedings* 46 (May), pp. 5-23.

Aigner, D., Lovell, C.A.K., Schmidt, P., 1977. Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics* 6, 21-37.

Alcala, F. and Ciccone, A., 2004. Trade and Productivity. *Quarterly Journal of Economics,* 119 (2), pp. 613-46.

Arestis, P., Chortareas, G. and Desli, E., 2006. Financial development and productive efficiency in OECD countries: An exploratory analysis, Manchester School 74(4), pp. 417-440.

Ark van, B., O'Mahony, M. and Timmer, M.P., 2008. The Productivity Gap between Europe and the United States: Trends and Causes. *Journal of Economic Perspectives* 22(1), pp. 25-44.

Baier, S.L., Dwyer Jr., G.P. and Tamura, R., 2006. How Important are Capital and Total Factor Productivity for Economic Growth? *Economic Inquiry* 44(1), pp. 23-49 (January).

Balk, B., 1997. Industrial Price, Quantity, and Productivity Indices: Micro- Economic Theory, Mimeographed, Statistics Netherlands.

Banker, R., Charnes, A. and Cooper, W., 1984. Some models for estimating technical and scale inefficiencies in data envelopment analysis. Management Science, 30, pp. 1078-1092.

Baris, Y., 2007. Human Capital, Innovation, and Productivity Growth: Tales from Latin America and Caribbean. MPRA Paper No. 3667.

Barro, R.J. and Jong-Wha Lee, 1993. International Comparisons of Educational Attainment. *Journal of Monetary Economics* 32 (December), pp. 363-94.

Baumol, W.J., 1990. Entrepreneurship: Productive, Unproductive and Destructive, *Journal of Political Economy* 98(5), pp. 893-921.

Berger, A.N. and Humphrey, D.B., 1997. Efficiency of Financial Institutions: International Survey and Directions for Future Research. *European Journal of Operational Research,* Vol. 98, No. 2, pp. 175-212, Apr 16.

BERI-Business Environment Risk Intelligence, Geneva: Switzerland <http:// www.beri.com>

Bertelsmann Foundation, Bertelsmann Transformation Index (BTI). Berlin: Germany. <http://www.bertelsmann-stiftung.de/>

Bjørnskov, C., Foss, N.J., 2010. Do economic freedom and entrepreneurship impact total factor productivity? Center for Strategic Management and Globalization (SMG) Working Paper No. 8/2010

Breusch, T. and Pagan, A., 1979. A simple test for heteroscedasticity and random coefficient variation. *Econometrica* 47, pp. 1287-1294.

Brock, W.A., Durlauf, S.N., 2001. What have we learned from a decade of empirical research on growth? Growth empirics and reality. World Bank Econ Rev 15 (2), pp. 229-272.

Caselli, F., 2005. Accounting for Cross-Country Income Differences, In: P. Aghion, S. Durlauf (eds.), Handbook of Economic Growth. Elsevier, Amsterdam.

Castellacci and Zheng, 2008. Technological Regimes, Schumpeterian Patterns of Innovation and Firm Level Productivity Growth. Working paper.

Caves, D.W., Christensen, L.R. and Diewert, W.E., 1982. The Economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity. *Econometrica,* November 50(6), pp. 1393-1414.

Chanda, A., Dalgaard, C.-J., 2008. Dual Economies and International Total Factor Productivity Differences: Channelling the Impact from Institutions, Trade, and Geography. *Economica* 75, pp. 629-661 (November).

Chang, C. and Luh, Y., 1999. Efficiency Change and Growth in Productivity: the Asian Growth Experience, *Journal of Asian Economics,* 10, pp. 551-570

Charnes, A., Cooper, W. and Rhodes, E., 1978. Measuring the efficiency of decision-making units. *European Journal of Operational Research,* 2, pp. 429-444.

Coelli T., Prasada Rao, D.S. and Battese, G.E., 1999. *An introduction to efficiency and productivity analysis.* Kluwer Academic Publishers, USA.

Cook, R.D. and Weisberg, S., 1983. Diagnostics for heteroscedasticity in regression. *Biometrika* 70, pp. 1-10.

Debreu, G., 1951. The Coefficient of Resource Utilization, *Econometrica,* Vol. 19, No. 2, pp. 273-292.

Deliktaş, E. and Balcilar, M., 2002. A Comparative Analysis of Productivity Growth, Catch-Up and Convergence in Transition Economies Paper Presented at the 6th METU Conference on Economics, Ankara.

Denison, E.F., 1985. *Trends in American Economic Growth, 1929-1982.* Washington: Brookings Institution.

Dimelis, S.P. and Dimopoulou, M., 2002. Evaluating Productivity Growth Measures in the EU. Economics of Planning 35, pp. 161-181.

Dismuke, C.E. and Sena, V., 1999. Has DRG Payment Influenced the Technical Efficiency and Productivity of Diagnostic Technologies in Portuguese Public Hospitals? An Empirical Analysis Using Parametric and Non-Parametric Methods. *Health Care Management Science,* Vol. 2, issue 2, pp. 107-16, May 1999.

Easterly, W. and Levine, R., 2003. Tropics, germs, and crops: the role of endowments in economic development. *Journal of Monetary Economics,* 50, pp. 3-39.

Färe, R., Grosskopf, S. and Lovell, C.A.K., 1985. *The Measurement of Efficiency of Production,* Boston: Kluwer Academic Press.

Färe, R., Grosskopf, S., Norris, M. and Zhang, Z., 1994b. Productivity Growth, Technical Progress, and Efficiency Change in Industrialized Countries. *The American Economic Review* 84(1), pp. 66-83 (March)

Färe, R., Grosskopf, S., Norris, M. and Lovell, C.A.K., 1994a. *Production frontiers. Cambridge:* Cambridge University Press.

Färe, R., Grosskopf, S. and Roos, P., 1997. Malmquist productivity indexes: A survey of theory and practice. In: Färe, R., Grosskopf, S., Russell, R.R. (Eds.), *Index Numbers: Essays in Honour of Sten Malmquist.* Kluwer Academic Publishers, Boston.

Färe, R., Grosskopf, S., Lindgren, B. and Roos, P., 1992. Productivity change in Swedish pharmacies 1980-1989: A nonparametric Malmquist approach. *Journal of Productivity Analysis* 3, pp. 85-102.

Farrell, M.J., 1957. The measurement of productive efficiency. *Journal of the Royal Statistical Society,* Series A, General, 120, Part 3, pp. 253-281.

Global Integrity. Various editions. Global Integrity Report. Washington DC: USA, <http://www.globalintegrity.org/>

Growiec, J., 2008. A New Class of Production Functions and an Argument Against Purely Labor-Augmenting Technical Change, *International Journal of Economic Theory* 4(4), forthcoming.

Gumbau-Albert, M., 1998. Regional technical efficiency: A stochastic frontier approach. *Applied Economics Letters.* 5, pp. 623-726.

Gumbau-Albert, M., 2000. Efficiency and technical progress: Sources of convergence in the Spanish regions. *Applied Economics* 32, pp. 467-478.

Gwartney, J., Lawson, R. and Norton, S., 2008. Economic Freedom of the World: 2008 Annual Report. Economic Freedom Network. Fraser Institute, <http://www.freetheworld.org/>

Hall, R. and Jones, C.I., 1999. Why do Some Countries Produce So Much More output per worker? *Quarterly Journal of Economics,* 114, pp. 83-116.

Henderson, D.J. and Russell, R.R., 2005. Human Capital and Convergence: A Production-Frontier Approach, *International Economic Review* 46, pp. 1167-1205.

Jeon Byung, M. and Sickles, R.C., 2004. The Role of Environmental Factors in Growth Accounting. *Journal of Applied Econometrics* 19, pp. 567-591.

Jerzmanowski, M., 2007. Total factor productivity differences: Appropriate technology vs. efficiency. *European Economic Review* 51, pp. 2080-2110.

Jones, C.I., 1997. On the Evolution of the World Income Distribution. *Journal of Economic Perspectives* 11 (Summer) pp. 19-36.

Jorgenson, D.W., Frank, M. Gollop and Barbara M.F., 1987. *Productivity and US Economic Growth.* Harvard Economic Studies, Vol. 159. Cambridge: Harvard University Press.

Kaufmann, D., Kraay, A. and Mastruzzi, M., 2008. Governance Matters VII: Governance Indicators for 1996-2007. World Bank Policy Research, June.

Kendrick, J.W., 1961. *Productivity Trends in the United States.* New York: Princeton University Press for the National Bureau of Economic Research.

Klenow, P.J. and Rodriguez-Clare, A., 1997. The Neoclassical Revival in Growth Economics: Has It Gone Too Far?, In Bernanke, B. and Rotemberg, J.J. (eds.), NBER Macroeconomics Annual, MIT Press: Cambridge and London, pp. 73-103.

Klenow, P.J. and Rodriguez-Clare, A., 1997a. The Neoclassical Revival in Growth Economics: Has It Gone Too Far? In NBER Macroeconomics Annual 1997, ed. by Ben S. Bernanke and Julio J. Rotemberg, pp. 73-103. Cambridge: MIT Press.

Kneip, A., Simar, L. and Wilson, P., 2005. A simple, tractable bootstrap for DEA estimators in non-parametric frontier models. Mimeo.

Koop, G., Osiewalski, J. and Steel, M.F., 2000. Modeling the sources of output growth in a panel of countries. *Journal of Business and Economic Statistics* 18(3), pp. 284-299.

Koopmans, T., 1951. *Activity Analysis of Production and Allocation.* Wiley, New York.

Krüger, J.J., 2003. The global trends of total factor productivity: Evidence from the non-parametric Malmquist index approach, Oxford Economic Papers, 55, pp. 265-86.

Kumar, S. and Russell, R.R., 2002. Technological Change, Technological Catch-up, and Capital Deepening: Relative Contributions to Growth and Convergence, *American Economic Review,* June, 92 (3), pp. 527-548.

Lambsdorff, J.G., 2003. How corruption affects productivity. *Kyklos* 56(4), pp. 457-474.

Landon-Lane, J. and Robertson, P., 2005. Barriers to Accumulation and Productivity Differences in a Two Sector Growth Model. Mimeo (Rutgers University).

Li, Kui-Wai and Tung, L., 2010. Analyzing Productivity Growth: Evidence from China's Manufacturing Industries, Working Papers 201003, Ball State University, Department of Economics, revised December 2010.

Limam, Y.R. and Miller, S.M., 2004. Explaining economic growth: Factor accumulation, total factor productivity growth, and production efficiency improvement. University of Connecticut, Department of Economics, Working Paper Series No. 2004-20. Forthcoming in Quarterly Review of Economics and Finance.

M del Mar, S.-J. and Javier, S.-J., 2007. Corruption, efficiency and productivity in OECD countries. *Journal of Policy Modeling* 29, pp. 903-915.

Maddison, A., 1995. Monitoring the World Economy, 1820-1992. Paris: Development Centre of the Organization for Economic Co-operation and Development.

Malmquist, S., 1953. Index Numbers and Indifference Curves. *Trabajos de Estatistica,* No. 4, 1, pp. 209-42.

Mathur Somesh, K., 2007. Growth Accounting for Some Selected Developing, Newly Industrialized and Developed Nations from 1966-2000: A Data Envelopment Analysis. *Journal of world economic review* 2, pp. 169-201.

Maudos, J., Pastor, J.M. and Rano Lor, E.Ser., 2000. Convergence in OECD countries: technical change, efficiency and productivity. *Applied Economics,* 32, pp. 757-765.

Maudos, J., Pastor, J.M. and Serrano, L., 1999. Total Factor Productivity Measurement and Human Capital in OECD countries. *Economics Letters* 6(6), pp. 389-392.

Miller, T., Holmes, Kim R., with Kim Anthony B., Markheim, D., Roberts James, M. and Walsh, C., 2009. 2009 Index of Economic Freedom The heritage Foundation and Dow Jones & Company, Inc.

Milner, C. and Weyman-Jones, T., 2003. Relative National Efficiency and Country Size: Evidence for Developing Countries. *Review of Development Economics,* 7(1), pp. 1-14.

Nelson, R.P. and Pack, H., 1999. The Asian Miracle and Modern Growth Theory, *Economic Journal,* 109(457), pp. 416-436.

North, D.C., 1990. *Institutions, institutional change and economic performance.* Cambridge, MA: Cambridge University Press, New York.

North, D.C., 1981. *Structure and Change in Economic history.* New York, Norton.

Olson Mancur Jr., Sarna, N. and Swamy, A.V., 1998. Governance and growth: A simple hypothesis explaining cross country difference in productivity growth. Working paper 218, center for institutional reform and the informal sector forthcoming in public choice.

Olson, M., 1982. *The Rise and Decline of Nations.* New Haven: Yale University Press.

Osiewalski, J., Koop, G. and Steel, M.F.J., 2000. A Stochastic Frontier Analysis of Output Level and Growth in Poland and Western Economies. *Economics of Planning* 33(3), pp. 185-202.

Polity-Marshall, M.G., and Keith, J., Various years. Polity IV Project. Center for Systemic Peace. <www.systemicpeace.org/polity>

PRS-Political Risk Services. International Country Risk Guide (ICRG). New York <http://www.prsgroup.com/>

Restuccia, D., 2004. Barriers to Capital Accumulation and Aggregate Total Factor Productivity. *International Economic Review,* 45, pp. 225-238.

Sarel, M., 1997. Growth and Productivity in ASEAN Countries', IMF Working Paper, WP/97/97, International Monetary Fund.

Sealey, C. and Lindley, J., 1977. Inputs, outputs, and a theory of production and cost at depository financial institutions. *Journal of Finance* 32, pp. 1551-1566.

Sharma, S.C., Sylwester, K. and Margono H., 2007. Decomposition of Total Factor Productivity Growth in U.S. States. *The Quarterly Review of Economics and Finance* 47, pp. 215-241.

Siddiqui, D.A. and Ahmed, Q.M., 2013a. The Effect of Institutions on Economic Growth: A Global Analysis Based on GMM Dynamic Panel Estimation. *Structural Change and Economic Dynamics* 24, pp. 18-33.

Siddiqui, D.A and Ahmed, Q.M., 2013b. Are Institutions a crucial Determinant of Cross Country Economic Efficiency? A two-stage Double Bootstrap Data Envelopment Analysis.) IBA Working paper series No. 2.

Simar, L. and Wilson, P.W., 1998. Sensitivity analysis of efficiency scores: How to bootstrap in non-parametric frontier models, *Management Science,* 44, pp. 49-61.

Simar, L. and Wilson, P.W., 2000. A general methodology for bootstrapping in non-parametric frontier models. *Journal of Applied Statistics,* 27(6), pp. 779-802.

Simar, L. and Wilson, P.W., 2007. Estimation and inference in two stage, semi-parametric models of productive efficiency. *Journal of Econometrics,* 136, pp. 31-64.

Solow, R.M., 1957. Technical Change and the Aggregate Production Function. *Review of Economics and Statistics* 39 (August), pp. 312-20.

Summers, R. and Alan, H., 1988. A New Set of International Comparisons of Real Product and Price Levels Estimates for 130 Countries, 1950-1985. *Review of Income and Wealth* 34, pp. 1-25, March.

Sun, C.-H., 2004. Market Imperfection and Productivity Growth – Alternative Estimates for Taiwan. *Journal of Productivity Analysis* 22, pp. 5-27.

Taskin, F. and Zaim, O. 1997. Catching-up and innovation in high- and low-income countries, *Economics Letters,* 54, pp. 95-100.

Thanassoulis, E., 2001. *Introduction to the Theory and Application of Data Envelopment Analysis: A Foundation Text with Integrated Software,* Kluwer Academic Publishers, Dordrecht.

WEF-World Economic Forum. Various editions. Global Competitiveness Report. Oxford, UK.

Wilson, P.W., 2008. FEAR: A software package for frontier efficiency analysis with R. Socio-Economic Planning Sciences, 42(4), pp. 247-254.

World Bank, 1993. The East Asian Miracle: Economic Growth and Public Policy. New York: Oxford University Press.

World Bank. Various editions. Doing Business. World Bank, the International Finance Corporation and Palgrave Macmillan.

World Development Indicators. 2008. World Bank.

Wu, Y., 2000. Is China's economic growth sustainable? A productivity analysis. *China Economic Review* 11, pp. 278-296.