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1 August 2010

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Abstract

Lifting the long run growth rate is, arguably, the pursuit of every economy. What should Kenya do to enhance its long run growth rate? This paper attempts to answer this question by examining the determinants of total factor productivity (*TFP*) in Kenya. We utilized the theoretical insights from the Solow (1956) growth model and its extension by Mankiw, Romer and Weil (1992) and followed Senhadji's (2000) growth accounting procedure. We find that growth in Kenya, until the 1990s was mainly due to factor accumulation. Since then, *TFP* has made a small contribution to growth. Our findings imply that while variables like overseas development aid, foreign direct investment and progress of financial sector improves *TFP*, trade openness is the key determinant. Consequently, policy makers should focus on policies that improve trade openness if long run growth rate is to be raised.

Keywords: Solow model, growth accounting, total factor productivity

JEL Numbers: O10; O15

* The authors are grateful to Professors B. Bhaskara Rao, Dimitris Christopoulos, Moses Oketch, G. De Vita, Jacob Oduor, A.Z. Baharumshah and Kanayo Ogujiuba for critical comments and helpful suggestions. All errors are the authors' responsibility.

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I. INTRODUCTION

Lifting the long run growth rate is an important objective of every economy. What should Kenya do to enhance its long run growth rate? This paper attempts to answer this question by examining the determinants of total factor productivity (*TFP*) in Kenya. We shall use the theoretical framework of Solow's (1956) growth model and the growth accounting framework in Solow (1957). The Solow growth model implies that the long run growth rate of an economy depends on the rate of technical progress or *TFP* and his growth accounting framework showed that nearly half of the long run growth rate in the developed countries is due to *TFP*. However, it is not known what factors determine *TFP* and for this reason the Solow growth model is known as the exogenous growth model (*EXGM*).

Subsequently, two alternative developments have taken place to analyse the determinants of *TFP*. Romer (1986; 1990), Lucas (1988) and Barro (1991; 1999) etc., have developed the endogenous growth models in which *TFP* is endogenously determined by factors like the stock of knowledge through education and research and development, investment in human capital formation and in infrastructure etc. While these endogenous growth models (*ENGM*) are very useful they have a few limitations. Firstly, they are difficult to estimate because their structural equations are intrinsically non-linear in parameters and variables. Secondly, since the dependent variable is the long run growth rate it is necessary to proxy this rate with the average growth rate over longer spans of time. This reduces the number of observations for estimation. Therefore, in estimating *ENGMs* it is necessary to use cross-country data with a large cross-section dimension. Thirdly, there is no theoretical *ENGM* in which more than one or two variables are used to show

how they influence *TFP*. Consequently, empirical works based on *ENGM*s use by and large *ad hoc* specifications; see Easterly, Levine and Roodman (2004).

A second alternative is to extend the Solow growth model. This can be done in two ways. Senhadji (2000) has used the growth accounting framework of Solow (1957) to estimate *TFP*, as the Solow residual, for 88 countries. He then regressed the estimated *TFP*s on some potential determinants of *TFP*. This approach is recently used by Rao and Hassan (2010) to explain the long run growth rate of Bangladesh. In this paper we shall use this approach of Senhadji and Rao and Hassan to analyse the determinants of the long run growth rate of Kenya.[1]

This paper is organised as follows: Section II. provides a brief overview of the Kenyan economy and describes results from the few relevant studies on *TFP* growth in this country. Sections III. and IV., respectively, detail specification and empirical results. Section V. concludes.

II. BRIEF OVERVIEW OF KENYA ECONOMY

Improving the growth rate in Kenya is of paramount importance. This low income African country has experienced a slow recovery from the multiple shocks it endured in 2008 and 2009: post election violence in early 2008, sharp rises in oil and food prices, the global financial crises, and worst drought in a decade in 2009. An indication of the stagnation of the economy in 2009, was that the agricultural sector, the foundation of the economy, actually contracted by more than 3%. The drought also affected electricity supply, and thus impacted on general infrastructure services, as well as the manufacturing sector.

According to data from the World Bank, the GDP per capita in Kenya (in constant 2000 US$) has only recently returned to the level it was at in 1990 (GDP per capita of $450 in 1990, $453 in 2008). Additionally, its average rate of growth of output (*GDP*) from 1977 to 2007 was 2.3% with large fluctuations due to unexpected multiple shocks. During this period its per capita output grew only at 0.42% implying that this rate should be raised to 1.39% if Kenya aims to double its per capita output in 50 years time. Most importantly, detailed empirical investigation is required to investigate determinants of this growth rate and decompose the influence of the different factors that shape this trend.

Many approaches are available for studying the sources of economic growth, and in particular the basis of productivity growth. For African countries, very few studies have applied a growth accounting framework. In Kenya, determinants of productivity have only been partially examined. For example, Beaulieu (1990) investigated the changes in the input structure of production and found that such changes resulted in 11% of the growth in gross output over the time period of 1967 to 1986. Shaaeldin (1989) looked into the sources of industrial growth, and in addition to Kenya, also looked at Tanzania, Zambia and Zimbabwe over the period 1964 to 1983. They found an average negative growth rate for *TFP*, except for Zimbabwe, which had a positive but insignificant *TFP* growth rate. Mwega (1995) found that productivity growth in Kenya's manufacturing sector was dominated by labour and capital in the post independence period of 1965 to 1983, and by labour and *TFP* growth in the next decade. Finally, and more recently, Onjala's (2002) estimates of *TFP* showed that *TFP* growth contributed more to agriculture, than the manufacturing sector. Moreover, he found inconsistent evidence to support the link between *TFP* growth and trade policy.

Although these empirical studies offer significant insights on Kenya's economic performance, their empirical approach is equivocal. These studies have mainly utilised *OLS* estimation and this traditional method has been criticized for not addressing the endogeneity problems, see Engle and Granger (1987) and Enders (2004). Further, none of these studies have analyzed the relevance of a set of potential variables that influence growth. Therefore, our paper attempts to fill these gaps by applying the latest time series techniques such as Engle and Granger's (1987) two step method, Phillip and Hansen's (1990) Fully Modified Ordinary Least Squares and Pesaran et al's. (2001) Autoregressive Distributed Lag bounds test.

III. MODEL SPECIFICATION AND METHODOLOGY

Model Specification

Many earlier studies on growth have used somewhat *ad-hoc* specifications to examine the determinants of growth; see Rogers (2003) and Easterly, Levin and Roodman (2004). In contrast Senhadji's approach is based on the Solow (1956) growth model and the growth accounting framework of Solow (1957). He has also used an extension to the Solow growth model by Mankiw, Romer and Weil (1992, *MRW*). *MRW* have augmented the production function with human capital and showed that the Solow growth model can adequately explain the observed growth rates in the developed and developing countries. Therefore, following Senhadji we specify the Cobb-Douglas production function, augmented with human capital, and with the constant returns to scale as follows:

$$Y_t = A_t K_t^{\alpha} (H_t \times L_t)^{1-\alpha} \tag{1}$$

Take the logs of the variables in (1) to get:

$$\ln Y_t = \ln A_t + \alpha \ln K_t + (1-\alpha)(\ln L_t + \ln H_t) \tag{2}$$

Therefore the production function in its first difference is:

$$\Delta \ln Y_t = \Delta \ln A_t + \alpha \Delta \ln K_t + (1-\alpha)(\Delta \ln L_t + \Delta \ln H_t) \tag{3}$$

where Y = output, A = stock of knowledge, K = stock of capital, H = an index of human capital formation through education and L = employment. The latter 3 are the conditioning variables. In Solow model, the variable of interest is the per worker income y^*. The steady state output per worker can be expressed as:[2]

$$y^* = \left[\frac{s}{d+n+g} \right]^{\frac{\alpha}{1-\alpha}} \times A \tag{4}$$

$$\ln y^* = \frac{\alpha}{1-\alpha} \ln \left[\frac{s}{d+n+g} \right] + \ln A$$

Therefore

$$\Delta \ln y^* = 0 + \Delta \ln A = g \tag{5}$$

where d = depreciation rate, s = proportion of output saved and invested, n = growth of labour force and g = growth of the stock of knowledge. These are assumed to be invariant in (5). Solow model has useful implications on growth. First, when the economy is on its steady state and given that the parameters are constant, per worker income will grow at the rate of technical progress. In other words, if the technical progress is zero, per worker income will not grow. An important implication of Solow model is that government policies to increase investment ratio will have only permanent level effects i.e., higher investment rates will only increase per worker incomes. Such policies will have only transitory growth effects. If the policy makers wish to permanently raise the rate of growth of output, then they should implement policies to increase *g*.

The ARDL Method

We shall estimate the production function (1) with alternative methods to attain the share of profits which is crucial for the growth accounting exercise. Few commonly utilized techniques are London School of Economics Hendry's General to Specific (*GETS*) approach, Engle and Granger's (1987) two step method (*EG*), Phillip and Hansen's (1990) Fully Modified Ordinary Least Squares (*FMOL*S), Stock and Watson's (1993) Dynamic Ordinary Least Squares (*DOLS*), Johansen and Juselius (1990) maximum likelihood (*JML*) and Pesaran et al.'s (2001) Autoregressive Distributed Lag (*ARDL*) bounds test. Although the *JML* technique is widely used in empirical works, lately Rao, Singh and Kumar (2010) have argued that applied economists should use an estimation technique that is simple and easy to implement. We argue that all techniques may provide consistent cointegrating estimates if no endogeneity issues exist. A similar view was also taken by Rao (2007).

We apply the *ARDL* technique to examine the determinants of long run growth in Kenya, as well as compare our estimates with the *EG* and *FMOLS* techniques.[3] Applying the *ARDL* technique comprises two simple steps, see Pesaran and Pesaran (1997, p. 304). The first step entails testing for the existence of a cointegrating relationship between the variables. The *F* tests are utilized to test for the existence of cointegrating relationships. When a cointegrating relationship is observed, the *F* test dictates which variable should be normalized.

The asymptotic distributions of the *F*-statistics are non-standard under the null hypothesis of no cointegration relationship between the variables. Two sets of asymptotic critical values are provided by Pesaran and Pesaran (1997). The first set assumes that all variables are $I(0)$ while the second set assumes that all variables are $I(1)$. If the computed *F* values fall outside the inclusive band, a conclusive decision could be drawn without knowing the order of integration of the variables. More precisely, if the empirical analyses show that if the computed *F*-statistics is greater than the upper bound critical value, and then we reject the null hypothesis of no cointegration and conclude that there exists a long run cointegrating relationship between the variables. If the computed *F*-statistics is less than the lower bound critical value, then we cannot reject the null of no cointegration. In the second step of *ARDL* technique, an additional two-step procedure is required to estimate the model. The first stage is determining the lag order in the *ARDL* model by either the Akaike Information Criteria (*AIC*) or the Schwarz Bayesian Criteria (*SBC*). In the second stage, the cointegrating vector is estimated with the *OLS*, ie, the long run coefficients. Microfit 5.0 has the routines for these steps. The *ARDL* also entails estimating the short run dynamic *ARDL* model in the final step, however, we are interested in the equilibrium long run results only.

IV. EMPIRICAL RESULTS

Unit Root Tests

We first test for the time series properties of *Y, K,* and *LH.* The Augmented Dicky-Fuller (*ADF*) and Elliot-Rothenberg-Stock (*ERS*) tests are used and the results are presented in Table 1. The null hypothesis of non-stationarity of *Y, K, LH* is tested against the alternative hypothesis of stationarity[4]. Clearly, the *ADF* test indicate that the unit root null for the level variables cannot be rejected at 5% level. Alternatively, the null that their first differences contains unit roots is clearly rejected. Similarly, the computed *ERS* test statistics are more than the 5% critical values, implying that all the levels of the variables are non-stationary. However, the test statistics are lower than critical values for the first difference of these variables and reject the unit root null at 5% level. It is well known that the *ERS* is a powerful test than *ADF*, therefore we argue that the level variables are non-stationary and their first differences are stationary. This study employs annual data for Kenya over the period 1977 to 2008. Data was obtained from the International Monetary Fund (2010) and the World Bank (2010). Definitions of the variables are provided in the Appendix.

<Insert Table 1 here>

Production Function and Growth Accounting

The stylised value of capital share of output (α) is 1/3 especially in advanced countries. However, many growth accounting exercises have shown that α is slightly greater than 1/3 in developing countries, see for instance, Oketch (2006), Rao and Hassan (2010), Rao and Vadlamannati (2010). In what follows, we estimate the value of α with the *EG, FMOLS* and *ARDL* techniques. The results are provided in Table 2

<Insert Table 2 here>

In all three methods, the share of capital α is around 0.4 and statistically significant. For the purposes of our growth accounting exercise we select α as 0.410.[5] Note that the estimated α using the three methods is based on unconstrained equations ie, no constant returns. Therefore, when we tested the null that there is constant returns ($\alpha + \beta = 1$) in the unconstraint equations, the Wald test cannot reject the null hypothesis. The *ARDL* technique indicated that there exists a unique cointegrating relationship between *Y, K* and *LH*. The *SBC* criterion indicated a lag length of 2 periods. When *Y* is the dependent variable, the computed *F* statistic (7.9196) is greater than the upper bound of the 95 percent critical value (4.378) resulting in the rejection of the null hypothesis of no long run relationship.

Growth accounting allows one to break down growth into components that can be attributed to the observable factors to the growth of factor accumulation (capital stock, labour force and human capital) and the *TFP*. As noted earlier, *TFP* is so called Solow residual and this is our measure of ignorance of the determinants of growth. The estimated value of α (0.410) is vital because this is used in growth accounting exercise to estimate the *TFP*. Using this value, *TFP* is estimated as follows:

$$TFP = \Delta \ln Y - 0.410 \Delta \ln K - (1 - 0.410)(\Delta \ln H + \Delta \ln L) \qquad (6)$$

The results for growth accounting exercise for Kenya is reported in Table 3. During the period 1977-08, average output growth was 2.3% and factor accumulation and *TFP* grew, respectively, at nearly 96% and 4%. In all periods, the results show that factor accumulation has been the major factor for growth in Kenya. The contribution of *TFP* is virtually negligible. Growth in the period 1977-89 was entirely dominated by factor accumulation. The average growth of output in the same period was 1.2%. However, the average *TFP* grew at 5.26% in the period 1990-99 and further increased to 7.92% on average during 2000-08. During 2000s the average output growth was nearly 2% and this was mainly due to factor accumulation, although *TFP* growth was 7.92%. Based on the average annual per capita output growth rate of 0.42% over the period 1977 to 2008[6], this implies that it would require Kenya 165 years to double its current GDP per capita of $453 (2008 value, in US$ constant 2000). Similarly, if Kenya attempts to double its GDP per capita over the next 50 years, it requires the average annual per capita output growth rate to increase to 1.39%.

<Insert Table 3 here>

Determinants of TFP

In this section we examine the factors that determine the *TFP* for Kenya. According to Durlauf, Johnson, and Temple (2005), there are a large number of potential variables that affect *TFP*. However, data on time series variables are limited for developing countries and hence it becomes difficult to select and examine a large number of variables. Consequently, we selected 10 potential variables that affect *TFP* and these variables are: private consumption to GDP ratio (*PCY*), foreign direct investment to *GDP* ratio (*FDIY*), overseas development aid to *GDP* ratio (*ODAY*), current government spending to *GDP* ratio (*GY*), rate of inflation (π), *M2* to *GDP* ratio as a proxy for the development of the financial sector (*M2Y*), remittances by emigrant workers to *GDP* ratio (*RY*), trade openness proxied with the ratio of imports plus exports to *GDP* (*TO*), a dummy variable (*DUM*) to capture the effects of financial reforms and liberalization policies, and time trend (*T*) to capture the effects of other trended but ignored variables which may have positive or negative effects. The *ADF* and *ERS* unit root tests for these variables indicated that they are I(1) in levels.[7]

The cointegrating equations of *TFP* are reported in Table 4. Note that two of these selected potential variables were deleted because they were statistically insignificant in all regressions. These variables are *PCY* and *RY*. We used the remaining 8 variables to examine which of these have a significant impact on *TFP*. First we estimated the *TFP* function without *DUM* and *TO* using the *EG, FMOLS* and *ARDL* techniques. These results are *EG(1), FMOLS(1)* and *ARDL(1),* respectively. Here all the estimated coefficients are significant at conventional levels, except *M2Y*. The estimated variables also have expected signs. In *ARDL(1),* the null of no cointegration was rejected.[8] Second, when *DUM* was added with other potential variables (except *TO*), the *M2Y* became significant at the 10% level in *EG(2)* and at the 5% level in *FMOLS(2)* and *ARDL(2)*.[9] The estimates of *M2Y* have also increased mildly. The third set of results ie, *EG(3), FMOLS(3)* and *ARDL(3)* are interesting because this has useful policy implications.[10] Here *TO* is added to other potential variables and this is highly significant. All the other estimates are also significant at conventional levels, with expected signs. While variables like overseas development aid, foreign direct investment, progress of financial sector and trade openness have a significant positive impact on *TFP*, others such as current government spending and rate of inflation have detrimental effects. Note that the trend variable has been highly significant in all cases, except *EG(3), FMOLS(3)* and *ARDL(3).* In empirical works, highly significant trend signifies that the unknown determinants of growth are trended. An important implication of our long run results is that trade openness is the key determinant of *TFP* in

<Insert Table 4 here>

Kenya.[11] Therefore policy makers should focus on policies that enhance trade openness because this will increase *TFP* in Kenya.

V. CONCLUSIONS

In this article, we examined the determinants of *TFP* in Kenya using time series data for the period 1977 to 2008. We utilized the theoretical insights from the Solow (1956) growth model and its extension by Mankiw, Romer and Weil (1992) and followed Senhadji's (2000) growth accounting procedure. To the best of our knowledge, this is perhaps the first paper to use these frameworks to derive policies for long run growth for Kenya. Our growth accounting exercise showed that growth in Kenya, until the 1990s was mainly due to the factor accumulation. Since then, the *TFP* has made a small contribution to growth. We find that the capital share of output is around 0.4 in Kenya. The *ARDL* technique was used to test for cointegration and estimate the cointegrating vectors. To confirm the robustness of the results, we also used *EG* and *FMOLS* techniques. These three methods of estimation provided consistent results concerning the profit share of output and the factors that influence the *TFP*.

Our findings imply that the potential variables like overseas development aid, foreign direct investment, progress of financial sector and trade openness have significant positive impact on *TFP*. Alternatively, current government spending and rate of inflation seems to have adverse effects on *TFP*. However, trend variable has been highly significant when trade openness was ignored in the regressions. With trade openness, trend becomes weakly significant implying that trade openness is one of the key determinants of *TFP* in Kenya. Therefore policy makers should focus on policies that improve trade openness because this will increase *TFP* in

Kenya. A limitation of our study is that we did not examine the level and growth effects of trade openness in Kenya. Also the short run dynamic model of *TFP* is outside the scope of this paper, so is a potential area for future studies to investigate.

References

Barro, R. J. “Economic growth in a cross section of countries.” *Quarterly Journal of Economics,* 106(2), 1991, 407-43.

Barro, R. J. *Determinants of Economic Growth*. Cambridge, MA: The MIT Press, 1999.

Barro, R. J. and Lee, J.W. “A new data set of educational attainment in the world, 1950-2010.” National Bureau of Economic Research Working Paper No. 15902, 2010.

Beaulieu, E. “Structural change in Kenya, 1967-86.” Technical Paper No. 90-09. Long-Range Planning Unit, Ministry of Planning and National Development, Nairobi, Kenya, 1990.

De Vita, G., Endresen, K. and Hunt, L. C. “An empirical analysis of energy demand in Namibia.” *Energy Policy*, 34(18), 2006, 3447-3463.

Durlauf, S. N., Johnson, P. A., and Temple, J. R. W. “Growth econometrics,” In *Handbook of Economic Growth, Volume 1A,* Edited by P. Aghion and S. N. Durlauf. Amsterdam, North-Holland: Elsevier B.V., 2005, 555-677.

Easterly, W., Levine, R. and Roodman, D. “New data, new doubts: A Comment on Burnside and Dollar’s ‘Aid, Policies, and Growth’ (2000).” *American Economic Review*, 94, 2004, 774-80.

Enders, W. *Applied Econometric Time Series*. 2nd. ed. Hoboken NJ: John Wiely, 2004.

Engel, R. F. and Granger, C. W. J. "Cointegration and error correction representation, estimation and testing." *Econometrica*, 55(2), 1987, 251-76.

International Monetary Fund. *International Financial Statistics Online (IFS) database,* accessed June 20, 2010.

Johansen, S. and Juselius, K. "Maximum likelihood estimation and inference on cointegration—with applications to the demand for money." *Oxford Bulletin of Economics and Statistics*, 52(2), 1990, 169-210.

Lucas, R. "On the mechanics of economic development." *Journal of Monetary Economics*, 22(1), 1988, 3-42.

Mankiw, N. G., Romer, D. and Weil. D. "A contribution to the empirics of economic growth." *Quarterly Journal of Economics*, 107(2), 1992, 407-37.

Mwega, F. "Trade liberalization, credibility and impact: A case study of Kenya, 1972-94." Report for African Economic Research Consortium Collaborative Project on Trade Liberalization and Regional Integration in Sub-Saharan Africa, 1995.

Onjala, J. “Total factor productivity in Kenya: The links with trade policy.” African Economic Research Consortium Research Paper No. 118, November 2002.

Oketch, M.O. “Determinants of human capital formation and economic growth of African countries.” *Economics of Education Review*, 25(5), 2006, 554-64.

Pesaran, H. M. and Pesaran, B. *Working with Microfit 4.0: Interactive Econometric Analysis.* Oxford: Oxford University Press, 1997.

Pesaran, M.H., Shin, Y. and Smith, R.J. “Bounds testing approaches to the analysis of level relationships.” *Journal of Applied Econometrics*, 16(3), 2001, 289–326.

Phillips, P. and Hansen, B. “Statistical inference in instrumental variables regression with I(1) processes.” *Review of Economic Studies*, 57(1), 1990, 99-125.

Rao, B. B. “Estimating short and long run relationships: A guide for the applied economists.” *Applied Economics*, 39(13), 2007, 1613-1625.

Rao, B.B. ‘‘Time-series_econometrics of growth-models: a guide for applied economists.” *Applied Economics,* 42(1), 2010a, 73-86.

Rao, B. B. “Estimates of the steady state growth rates for selected Asian countries with an extended Solow model.” *Economic Modelling,* 27(1), 2010b, 46-53.

Rao, B.B. and Hassan, G. "An analysis of the determinants of the long run growth rate of Bangladesh." Forthcoming in Applied Economics, 2010.

Rao, B.B. and Rao, M. "Openness and growth in Fiji: some time series evidence,'Applied Economics." 41(13), 2009, 1653-1662.

Rao, B. B., Singh, R. and Kumar, S. "Do we need time series econometrics?" *Applied Economics Letters,* 17, 2010, 695-97.

Rao, B. B. and Tamazian, A. "A model of growth and finance: FIML estimates for India." MPRA Paper No. 8763, University Library of Munich, 2008.

Rao, B.B. and Vadlamannati, K.C. "Globalization and growth in the low income African countries with the extreme bounds analysis." MPRA Paper No. 21924, University Library of Munich, 2010.

Rogers, M. "A survey of economic growth." *The Economic Record*, 79, 2003, 112-35.

Romer, P. "Increasing returns and long run growth." *Journal of Political Economy*, 94(5), 1986, 1002-1037.

Romer, P. “Endogenous technological change.” *Journal of Political Economy,* 98(5), 1990, S71-8103.

Romer, D. *Advanced Macroeconomics*. 3rd. ed. New York: McGraw-Hill, 2006.

Senhadji, A. “Sources of economic growth: an extensive growth accounting exercise.” *IMF Staff Papers*, 47(1), 2000, 129-57.

Shaaeldin, E. “Sources of industrial growth in Kenya, Tanzania, Zambia and Zimbabwe: Some estimates.” *African Development Review,* 1(1), 1989, 21 – 39.

Solow, R. “A contribution to the theory of economic growth.” *Quarterly Journal of Economics*, 70(1), 1956, 65-94.

Solow, R. “Technological change and the aggregate production function.” *Review of Economics and Statistics*, 39(3), 1957, 312-20.

Sorensen, P.B. and Whitta-Jacobsen, H.J. *Introducing Advanced Macroeconomics: Growth and Business Cycles*. New York: McGraw-Hill, 2005.

Stock, J. H. and Watson, M. W. “A simple estimator of cointegrating vectors in higher order integrated systems” *Econometrica,* 61(4), 1993, 783–820.

World Bank. *World Development Indicators Online (WDI) database,* accessed June 20, 2010.

Table 1. ADF and ERS Unit Root Tests 1977-2008			
Variable	LAG	ADF	ERS
ln *Y*	[1,1]	2.025 (3.56)	5.026 (3.66)
Δln *Y*	[0,1]	3.076 (2.95)	2.051 (7.23)
ln *K*	[1,1]	-1.108 (3.56)	9.025 (2.85)
Δln *K*	[0,2]	7.028 (2.95)	7.041 (7.23)
ln *LH*	[2,1]	-1.735 (3.56)	10.256 (2.85)
Δ ln*LH*	[1,1]	4.942 (2.95)	4.120 (7.23)
Notes: LAG is the lag length of the first differences of the variables. For example [1,1] means that one lagged first difference is found to be adequate in the two test statistics, respectively. For both ADF and ERS, the absolute value 5% critical values are given below the test statistics in parentheses. A time trend is included because it is significant in levels and first differences of the variables.			

Table 2. Estimates of the Cointegrating Equations 1977-2008			
Production function	$Y_t = A_t K_t^{\alpha} (H_t \times L_t)^{\beta}$		
	Intercept	*A*	*β*
EG	1.725 (13.36)*	0.411 (2.01)*	0.629 (5.86)*
FMOLS	0.266 (2.03)*	0.437 (1.86)**	0.704 (3.46)*
ARDL	1.543 (9.05)*	0.410 (8.04)*	0.636 (5.35)*
The *t*-ratios are reported below the coefficients. * and ** denotes significance at 5% and 10% levels, respectively.			

Table 3. Decomposition of Growth					
	Mean $\Delta \ln Y$	Mean $\Delta \ln K$	Mean $\Delta \ln(L+H)$	Growth due to Factor Accumulation	Growth due to *TFP*
1977-2008	0.023	0.026	0.017	0.022	0.002
Contribution to Growth (%)				95.65%	4.35%
1977-1989	0.012	0.039	0.019	0.018	-0.006
Contribution to Growth (%)				150.00%	-50.00%
1990-1999	0.019	0.018	0.012	0.018	0.001
Contribution to Growth (%)				94.74%	5.26%
2000-2008	0.202	0.039	0.019	0.186	0.016
Contribution to Growth (%)				92.08%	7.92%

Table 4. Determinants of TFP 1977-2008									
	EG (1)	*FMOLS (1)*	*ARDL (1)*	*EG (2)*	*FMOLS (2)*	*ARDL (2)*	*EG (3)*	*FMOLS (3)*	*ARDL (3)*
C	1.914 (2.93)*	0.023 (2.72)*	1.002 (3.18)*	2.014 (2.45)*	2.183 (2.02)*	1.965 (4.06)*	1.143 (5.73)*	4.092 (8.01)*	4.665 (6.73)*
T	1.261 (7.23)*	0.762 (7.06)*	0.867 (6.58)*	0.963 (6.89)*	1.745 (8.11)*	4.316 (7.24)*	0.006 (1.75)**	0.350 (1.90)**	0.009 (1.69)**
$ODAY_t$	0.003 (1.75)**	0.003 (1.76)**	0.004 (1.69)**	0.009 (1.70)**	0.011 (2.10)*	0.017 (2.85)*	0.023 (1.87)**	0.106 (2.69)*	0.135 (2.88)*
$FDIY_t$	0.005 (1.85)**	0.002 (1.79)**	0.003 (1.90)**	0.010 (2.06)*	0.099 (1.84)**	0.027 (1.77)**	0.106 (1.86)**	0.108 (1.75)**	0.127 (1.90)**
GY_t	-0.003 (3.40)*	-0.004 (2.10)*	-0.003 (2.06)*	-0.007 (1.86)**	-0.054 (1.87)**	-0.008 (2.05)*	-0.012 (3.65)*	-0.099 (3.26)*	-0.018 (2.76)*
π_t	-0.777 (1.69)**	-0.579 (1.61)**	-0.599 (2.17)*	-0.487 (3.28)*	-0.400 (1.78)**	-0.362 (2.04)*	-0.206 (4.83)*	-0.206 (4.90)*	-0.599 (5.04)*
$M2Y_t$	0.002 (1.56)	0.005 (1.53)	0.009 (1.30)	0.010 (1.76)**	0.063 (2.12)*	0.174 (2.49)*	0.007 (2.56)*	0.018 (2.05)*	0.127 (2.08)*
DUM				0.037 (1.98)*	0.005 (2.07)*	0.019 (2.34)*	0.020 (2.07)*	0.086 (1.97)*	0.096 (2.07)*
TO_t							0.005 (5.63)*	0.017 (7.07)*	0.036 (7.12)*
The *t*-ratios are reported below the coefficients. * and ** denotes significance at 5% and 10% levels, respectively.									

Data Appendix

Variables	Definition	Source
Y	Real Gross Domestic Product	International Monetary Fund (2010)
K	Capital Stock; Derived using perpetual inventory method $K_t = .95 * K_{t-1} + I_t$. It is real gross domestic fixed investment	International Monetary Fund (2010)
L	Labour force	World Bank (2010)
H	Human capital; An average of educational attainment.	Barro and Lee (2010) data set.
RY	Workers' remittances and compensation of employees to GDP ratio.	World Bank (2010)
ODAY	Overseas development aid to GDP ratio.	World Bank (2010)
FDIY	Foreign direct investment to GDP ratio.	World Bank (2010)
M2Y	Money and quasi money (*M2*) to GDP ratio.	World Bank (2010)
GY	General government final consumption expenditure to GDP ratio.	World Bank (2010)
π	Rate of inflation (calculated using GDP deflator)	International Monetary Fund (2010)
TO	Sum of export plus import of goods and services to GDP ratio.	World Bank (2010)
PCY	Private consumption to GDP ratio	International Monetary Fund (2010)
DUM	Dummy variable to capture impact of financial reforms and liberalization policies. *DUM* is constructed as 1 from 1985-2008, 0 otherwise.	Authors computations

[1] Another alternative method is proposed by Rao and has been used in several works by him and his coauthors. See Rao (2010a and 2010b), Rao and Rao (2009), Rao and Tamazian (2008), Rao and Hassan (2010), Rao and Vadlamannati (2010), where this alternative method is used. In this approach Rao has extended the production function by making *TFP* a function of a few of its crucial determinants. He has then estimated the extended production function with country specific data and with cross-country data.

[2] Derivation of steady state output per worker is clearly presented in Romer (2006) and Sorensen and Whitta-Jacobsen (2005).

[3] In addition to *ARDL*, we are using *EG* and *FMOLS* and to obtain valid estimates with these latter techniques, tests for non-stationarity in the variables should be performed.

[4] When using the *ARDL* approach there is a need to test for unit roots to exclude the possibility of I(2) series. Justification for this is shown in De Vita et al (2006).

[5] We selected the *ARDL* share of capital (0.41) because this is highly significant.

[6] Based on World Bank data.

[7] The *ADF* and *ERS* unit root test results for potential variables are not reported to conserve space but can be obtained from the authors.

[8] The computed *F* statistic (8.834) was greater than the upper bound of the 95 percent critical value (4.378).

[9] In *ARDL(2),* the null of no cointegration was rejected because the computed *F* statistic (4.529) was greater than the upper bound of the 95 percent critical value (4.378).

[10] The null of no cointegration was also rejected in *ARDL(3).* The computed *F* statistic (5.843) was greater than the upper bound of the 95 percent critical value (4.378).

[11] We did interchangeably dropped and added other potential variables but trend remained highly significant.