Reshaping Management and Economic Thinking through Integrating Eco-Friendly and Ethical Practices
Proceedings of the 3rd International Conference on Management and Economics

26-27 February 2014
Faculty of Management and Finance, University of Ruhuna, Sri Lanka

Testing Conditional Convergence of Growth Under Mankiw-Romer-Weil's Test of Neoclassical Growth Model

Emran Seyed-Mohammad[a] and Hanas Cader[b]

[a]*Kuwait University, Kuwait. Emran.S.Mohammad@gmail.com*
[b]*American University of Kuwait, Kuwait. mcader@auk.edu.kw*

Abstract

Solow's neoclassical growth model predicts that countries with low capital stock tend to converge to their steady-state at a faster rate. This study attempts to test conditional convergence of GCC economies. The study finds significant empirical evidence of conditional convergence of the GCC economies over the period from 1971 to 2011 using the Mankiw et al. (1992) model. Using panel data estimation, the study estimates savings and population growth rates and their effects on income per capita in GCC economies. The results indicate significant negative relationship between domestic investment and output per capita due to net capital outflows. Capital inflows appear to be insufficient to offset the large investments by GCC governments abroad. A positive relationship between output per capita income and employment growth is found and is inconsistent with Solow's growth model predictions. Wage elasticity in estimation of conditional convergence supports the hypothesis that GCC economies grow in output per capita due to growth in government expenditure. Results found wages to have a positive relationship with income per capita. GCC economies tend to increase their welfare programs and wages as their output per capita grows. Due to the inadequate macroeconomic policies in GCC economies, estimation finds profits to have a negative relationship with income per capita, which is also inconsistent with Solow's predictions. It is believed to be attributed to GCC governments' generous welfare programs which tend to lower interest rates, thus lowering investments and profits. Speed of convergence for GCC economies is found to be a positive 0.219 which is attributed to net capital outflows of GCC economies, hindering growth of investments.

Keywords: *capital; convergence; investment; growth; labour*

1. Introduction

In the recent years, there has been a number of empirical works on endogenous growth theories. However, some of the work has assumed identical aggregate production functions across all countries. Later, it was proposed that each country differ in its production function. Thus it was proposed that each country would have a different rate of convergence to the level of steady state, which brought about the issue of conditional convergence. This paper uses panel data approach to test whether this applies for GCC countries. It is assumed that output per capita is dependent on growth of savings and labor force. The higher the savings, the higher the capital per worker, and the higher the growth of labor force, the higher the output produced assuming a parallel growth of capital available for the labor force. The higher these growth rates, the faster the country would be able to converge to its steady-state.

As discussed in the Solow growth model, countries with low capital stock per labor would grow at a faster rate (converge) to their steady-state when capital is increased. This is attributed to the assumption of diminishing marginal returns to capital. The theory suggests that convergence is higher the savings and

investments in the poor countries, the higher is the growth of output; consequently, the higher the speed of convergence "catch-up" to their steady-state relative to rich countries. It is said that convergence is conditional because steady-state income per capita is conditional to, among others, growth in savings and population, which differ across countries. Technology and its role of enhancing production by efficiently setting the capital and labour configuration to maximize output is assumed constant across all countries because it can be attained by all countries, eventually. Although it is argued that patents and other factors restrict the free transfer of technology to all countries, it is believed that measuring technology across countries in the model is problematic. Depreciation is considered constant across all countries as well. Since these two factors are either constant across countries or difficult to adequately measure, their variables can be dropped from the model and the study focuses on growth of savings and labor force as main drivers of growth of output per capita.

Solow's growth model predicts that convergence is conditional, and (λ) is the measure of how much time takes countries to reach their steady-state. In order to test for conditional convergence across countries, the study uses panel data regression on GCC countries. The study compares the difference in the speed of convergence between developing and developed economies given the level of growth in savings and labor force as exogenous factors. The study compares estimates on GCC countries with estimates of Felipe and McCombie (2004 and 2005) on OECD countries.

2. Literature Review

According to the predictions of Solow's (1956) growth model, steady-state output per worker is positively correlated with savings, which increase investments and thus capital per worker. Also, it is predicted that population growth rate is negatively correlated with steady-state output per worker as it lowers capital per worker and thus lowers output per worker. Solow growth model predict that rich economies would have higher savings rate and lower population growth rate compared to poor economies. This also explains the variations in income levels across countries, but the variations in growth rates is due to differences in technological growth rate. However, according the neoclassical growth model, economies beginning with below steady-state capital stock per worker tend to grow in per capita income at a faster rate than countries that reached their steady-state per capita income. In other words, poor economies converge (catch-up) at a faster rate.

Mankiw et al. (1992) further examined Solow growth model to test whether poor economies tend to converge at a faster rate to steady-state than rich economies. While holding savings and population growth rates constant, they found that convergence is consistent with Solow's augmented model predictions. Mankiw et al. (1992) also found that these two variables alone are responsible for more than half of the variation in per capita income across a large set of countries. Their model was based on three samples of countries: Non-oil, intermediate, and OECD. However, Mankiw et al. (1992) excluded oil producing economies as these economies' per capita income is heavily reliant on their natural resources. A second estimate including human capital proved that it enhances the model. Then they turned to the issue of convergence and that countries with higher saving rates tend to grow at a faster, holding preferences and technology constant across all countries. Mankiw et al. (1992) found that OECD economies have a higher convergence rate due to the bigger impact of World War II on these economies compared to others. These estimates are consistent with Solow model. Finally, Mankiw et al. (1992) concluded that savings rate plays an important role in increasing income to reach steady-state, human-capital and total factor productivity, and population growth rate does the opposite at a bigger scale.

Islam (1995) used panel data to estimate convergence to account for differences in production function across countries. The study used Mankiw et al.'s data excluding Indonesia and Burkina Faso, so OECD sample size remained unchanged in regression. Islam (1995) used single cross-section estimations in order to compare the differences in his results compared to Mankiw et al.'s estimations. Islam (1995) found the results to be "very similar". From the estimations, Islam (1995) concluded that differences in income per capita across countries are not mainly because of differences in savings and population growth rates, but rather also due to

differences in technology and depreciation. Differences in technology and depreciation significantly affect the speed convergence across countries. The study suggested rearranging countries into groups based on similar technology level; however the criteria are "problematic". Panel estimation showed no significant change in results when including human capital. The study found that countries with similar saving and population growth rates tend to converge at different rates due to differences in policies affecting technology. In other words, countries that implement policies that promote technological progress tend to grow in per capita income at a faster rate.

Caselli, Esquivel, and Lefort, (1996) compared OLS and panel data to estimate convergence and found that country-specific effect is an important factor and panel estimation reviles that. Moreover, panel estimation is argued to take into account the effect of business cycles which OLS does not and cause bias estimates. By employing Hausman tests on the unrestricted and restricted Solow models to determine the exogeneity of the regressors, a strong rejection was found in the unrestricted regression. It was argued that the endogeneity of the regressors (investment and population growth) violates Solow's assumption of the exogeneity of these variables. In testing for speed of convergence, the study found it to be about 10 percent per year, indicating that it takes an economy an average of seven years to be half way through from its initial to its steady-state. In light of the findings, the study attributes steady-state variations by country to be the main factor of gaps in income per capita. Due to high convergence rate, the study supports the elimination of international trade barriers.

Barro, (1998) used panel estimation and found evidence of conditional convergence. The study found that schooling and life expectancy to play a positive role in growth of income per capita while fertility, government consumption and inflation to have a negative effect on growth. The study concluded that government policies play a major role in determining the speed of convergence. The main policies are related to pensions and other transfer programs and regulations governing labor and capital (financial and other markets). Development of terms of trade and enforcing law appear to have a positive effect on growth as well. Nevertheless, factors such as investments in upgrading the infrastructure of the economy, expenditure on research and development and development of education and distribution of income and wealth are found to be significant in increasing long-term economic growth.

Edwards (2005) reviewed and compared the work of Mankiw el al. (1992) and Islam (1995) in order to determine whether the assumptions were violated and thus yielded biased estimations. The study confirmed that the estimations in Mankiw et al.'s models were actually biased and Islam's model is more accurate than Mankiw et al.'s. Moreover, the study pointed out, contrary to Mankiw et al.'s conclusions that the variable human capital (schooling) does not always tend to allow countries to converge at a faster rate and lower the role of capital in output.

Felipe and McCombie (2004 and 2005), followed by the seminal work of Mankiw el al. (1992), assigned different technological progress rates and found it to improve Mankiw et al.'s goodness of fit. Nevertheless, Felipe and McCombie suggest that the results were "statistical artifact" because the results were based on data that did not aggregate labor and capital. The study doubted whether Mankiw et al.'s model based on the neoclassical growth model could explain output growth, development and convergence and suggested a different approach. The study argued that the neoclassical approach did not explain the differences in income per capita across countries.

Mehanna (2006) argued that economic growth causes growth in investment, as opposed to Solow's neoclassical growth theory. The study used panel estimation on randomly selected countries from North and South America, Europe, and Southeast Asia. Trade openness was used to test its impact on economic growth, and found that it absorbed most of what investment explained as a regressor. Other factors in estimation included education, life expectancy, fertility, government expenditures, and terms of trade. Trade openness was found positively and significantly related to growth of per capita income. Last and most importantly, the study found that growth of per capita income actually causes investment to grow. Thus, trade liberalization through government policies tends to increase growth of per capita income more effectively than policies aim-

ing at increasing local savings and investments.

3. Methodology

The study is based on assumptions on Solow's growth model and start with the standard aggregated Cobb-Douglas production function with constant returns to scale:

$$Y_{(t)} = [A(t)L(t)]^{(1-\alpha)} K(t)^{(\alpha)} \quad (1)$$

Where Y is output, L is the labor input, K is the capital stock and 1-α and α are the labor's and capital's output elasticities (1< α <0). A is a measure of the level of technology. Labor and technology were assumed to grow at constant exponential rate. Depreciation of capital stock is assumed to be constant across countries. Part of the output is assumed to be saved over time, but that rate differs across countries. The study is based on Felipe and McCombie (2004 and 2005) models, but specify a panel data model, because it is believed that OLS estimation would yield biased estimates. Upon substitution of the assumptions into the productions, the model for steady-state productivity is explained in the remaining methodology.

The study employs panel regression on GCC countries to identify the factors influencing the output per capita. The basic panel specification is as follows:

$$\ln y = \alpha + \beta_1 \ln s + \beta_2 \ln n + \beta_3 \ln w + \beta_4 \ln r + \gamma + \varepsilon \quad (2)$$

Where, y is real GDP per capita, s is the investment–output ratio, n is the rate of growth of the working-age population, w is the wage rates, r is the profit rates, and α and β are the intercept and coefficients, respectively, γ is the country specific effect and ε is the error term. And to test the speed of convergence:

$$(\ln y_t - \ln y_o) = \alpha + \beta_1 \ln s + \beta_2 \ln n + \beta_3 \ln y_o + \gamma + \varepsilon \quad (3)$$

Where (ln yt - ln yt0) is the change in real GDP per capita, s is the investment–output ratio, n is the rate of growth of the working-age population, y0 is the initial point and its elasticity is the speed of convergence, and α and β are the intercept and coefficients, respectively, γ is the country specific effect and ε is the error term.

The data used to estimate the variables are from the Penn World Table, Center for International Comparisons (PWT 8.0). The following were used as proxies for estimation: Output-side real GDP at chained PPPs (in mil. 2005US$) divided by Population (in millions) to represent the real GDP per capita (y); share of gross capital formation at current PPPs to represent the investment-output ratio (s); number of persons engaged (in millions) to represent the rate of growth of the working-age population (n); share of labour compensation in GDP at current national prices to represent the wage rates (w); share of household consumption at current PPPs to represent profit rates (r).

Table 1: Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
y	205	54075.090	82960.380	8595.932	575847.600
s	205	0.270	0.112	0.039	0.990
n	205	0.061	0.061	-0.086	0.338
w	205	0.302	0.073	0.175	0.424
r	205	0.351	0.174	0.054	1.447

For GCC countries panel regression, the study used data on 5 GCC countries, namely Bahrain, Kuwait, Oman, Qatar and Saudi Arabia over the period from 1971-2011.

4. Results

The study estimated the model 2 using fixed and random effects estimation and the subsequent Hausman test results showed a significant P-value, meaning that fixed-effects is the most efficient model for the study's panel estimation.

Table 2: Fixed-effects (within) panel estimates of MRW's specification of Solow's model

Constant	(β1) ln s	(β2) ln n	(β3) ln w	(β2) ln r	R-sq
12.090 *	-0.237 **	0.204 *	1.680 *	-0.576 *	0.013 *
(-0.732)	(-0.098)	(-0.051)	(-0.536)	(- 0.084)	

Standard error in parentheses
*Significant at 1%
** Significant at 5%

In comparing the study's savings estimate with Felipe and McCombie (2004 and 2005), the study found savings to be a negative -0.237, while they found it to be a positive 0.586 for OECD countries. One possible explanation for savings to be negative is because GCC countries are heavily reliant on their oil exports, which tends to increase their net capital outflow. As a result, most of their investments are abroad. Consequently, local savings are from abroad, but do not offset the large investments GCC countries invest abroad. This is consistent with the issue of increasing generous welfare programs GCC countries provide for their citizens which also tend to decrease local savings. GCC economies are driven by government expenditure which crowds out investments. This is a major issue in GCC economies as the role of the private sector is weak.

In terms of employment growth, the study found it to be a positive 0.204 while Felipe and McCombie (2004 and 2005) found it to be a negative 0.605 for OECD countries. It is believed that the reason behind a positive relationship between output per capita income and employment growth is mainly because GCC economies are driven by demand for oil. GCC economies' suffer from disguised unemployment. Most GCC nationals are employed in the public sector due to many employment incentives over employment in the weak private sector. As a result, growth in employment grows as GCC economies grow in output which is driven by increasing net exports. This is inconsistent with Solow growth model which predicts that an increase in population tends to decrease capital available for existing labor, thus decreasing output per labor and driving the economy farther from steady-state. GCC economies also tend to grow in employment because the main driver for growth in output per capita is government expenditure which itself being driven by oil demand.

Wage elasticity in the study's estimate of equation (2) supports, to some extent, the study's hypothesis that GCC economies grow in output per capita due to growth in government expenditure. The study found wages to be a positive 1.68, compared with 1.001 in Felipe and McCombie (2004 and 2005) estimate on OECD countries. GCC economies tend to increase their welfare programs and wages as their output per capita grows. In fact, wages have the second highest elasticity after employment growth.

Finally, due to the inadequate macroeconomic policies in GCC economies, the study find profits to be a negative 0.576, compared to a positive 0.833 in Felipe and McCombie (2004 and 2005) estimate on OECD countries. The difference between the study's estimate and Felipe and McCombie (2004 and 2005) is that GCC economies, due to their generous welfare programs, tend to lower interest rates, thus lowering investments and profits. So the more output per capita grows, due to increasing oil demand, investment environment in GCC economies worsens. This is consistent with the theory of natural resource curse. On a final note, there may be a need to include other regressors to improve the model, as its R-sq is a low 1.3% and there are region related factors affecting growth of per capita income.

Similar to model 2, a panel data were used in model 3, specifying fixed effect and random effect model. The Hausman test for equation 3 results indicates the fixed-effect model is more appropriate. Table 3 presents the results from the fixed effect model.

Table 3: Fixed-effects (within) panel estimates for conditional convergence

Constant	(β1) ln s	(β2) ln n	(β3) ln yo	R-sq
-2.480	-0.138	-0.019	0.219	0.093
(- 0.652)	(-0.041)	(-0.012)	(- 0.059)	
Standard error in parentheses				
*Significant at 1%				

In comparing the study's estimates with Felipe and McCombie (2004 and 2005) the study finds savings to be a negative 0.138 for GCC economies while Felipe and McCombie (2004 and 2005) find it to be a positive 0.447 for OECD countries. Employment growth is found to be a negative 0.019 in GCC economies compared with a negative 0.649 for OECD economies in Felipe and McCombie (2004 and 2005) estimates. Speed of convergence, given by y0, is found to be a positive 0.219 (21.9% per year) compared with a negative 0.352 (35.2% per year) in Felipe and McCombie (2004 and 2005) estimates. This is inconsistent with Solow's predictions that developing economies tend to converge at a faster rate than developed economies. A possible explanation for the slow convergence rate for GCC economies compared to OECD countries' convergence rate found in Felipe and McCombie (2004 and 2005) estimates is that there are structural macroeconomic issues restraining GCC economies from converging to steady-state at a faster rate than OECD economies. Another possible factor is the net capital outflows of GCC economies, hindering growth and investments. In addition, GCC economies suffer from disguised unemployment in the public sector for the most part which lowers efficiency, thus not all factors of production are fully employed. The study concludes that GCC economies have the properties of poor economies which have low savings (investments) and high population growth rates compared to rich economies.

5. Conclusion

Production function differences in respective economies leads to country's convergence to its steady-state income at a different rate. Technology and depreciate also differ across countries, resulting different convergence rates. Technology and depreciation are, to some extent, difficult to measure; thus, it is difficult to regroup countries in panel estimation based on their level of technological progress. According to Solow's growth model, it is predicted that the higher the savings, the higher the capital per worker, and the higher the growth of labor force, the higher the output produced assuming a parallel growth of capital available for the labor force. The higher these growth rates, the faster the country would be able to converge to its steady-state. The study estimated the role of savings, population growth, and wages and profits for GCC economies using panel fixed-effects regression and found the following: (i) savings are negatively correlated with output per capita as GCC economies have high net capital outflows from oil exports, (ii) employment growth is driven by oil exports and the private sector is being crowded out by the public sector, (iii) wages tend to grow at a relatively higher rate in GCC economies compared to OECD due to generous welfare programs in GCC economies, (iv) profits are negatively correlated with output per capita due to investments being crowded out by GCC governments' increasing endowments which lower interest rates and discourage investments and thus profits, and (v) GCC economies tend to converge at a lower rate due to inadequate policies that hinder efficient growth of output per capita.

The study suggests major macroeconomic reforms to be implemented in GCC economies to efficiently allocate resources that would yield sustainable growth in per capita income. First, the study suggests major investments by GCC governments in the private sector in order to let the private sector lead the economy efficiently toward steady-state income. Second, there needs to be major investments in diversifying GCC economies' income stream in order to lower the standard deviation of output per capita (82,960.380) and thus provide more efficient allocation of resources to increase capital per worker. Third, lower government

expenditure on welfare program and reallocate resources toward investments in technology. Fourth, eliminate investment laws that restrain capital inflows, improve international trade laws to attract foreign direct investments in GCC economies that brings new technology that enhances local workers' output and enhance GCC financial markets to increase the growth rate of the economy.

Given the low R-sq of the estimations, there is a need for further examination of the role of other variables affecting growth of per capita income. The study suggests variables to be included in the model such as technology, schooling, fertility, government consumption, inflation, policies regarding labor and capital mobility, pensions and transfer programs, regulations on trade, trade openness, wealth distribution, and corruption. Other interesting factors to examine are population growth by age groups, poverty, mortality, democracy, tariffs and taxation, and the role of the private sector. Nevertheless, it is crucial to study the effect of disguised unemployment on growth of per capita income in GCC economies as it is assumed to be significantly suppressing growth.

References

Barro, R. J. (1998). Determinants of Economic Growth: A Cross-Country Empirical Study. *MIT Press, Ed. 1, Vol. 1, Number 0262522543*.

Caselli, F., Esquivel, G., & Lefort, F. (1996). Reopening the Convergence Debate: A New Look at Cross-Country Growth Empirics. *Journal of Economic Growth, Vol. 1*, 363–389.

Edwards, J. (2005). The Great Growth Debate: A Statistical Look at Mankiw, Romer, and Weil,versus Islam. *Atlantic Economic Journal, Vol. 33*, 71–92.

Felipe, J., & J. S. L., M. (2005). Why Are Some Countries Richer than Others? A Skeptical View of Mankiw-Romer-Weil's Test of the Neoclassical Growth Model. *Metroeconomica, Vol. 56(3)*, 360-392.

Islam, N. (1995). Growth Empirics: A Panel Data Approach. *The Quarterly Journal of Economics, Vol. 110, No.4*, 1127-1170.

Mankiw, N. G., Romer, D., & N. Weil, D. (1992). A Contribition to the Empirics of Economic Growth. *The Quarterly Journal of Economics, Vol. 107, No. 2*, 407-437.

Mehanna, R.-A. (2006). Open First; Then Invest. *Journal of Transnational Management, Vol. 11(2)*, 53-75.

Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics, Vol. 70, No. 1*, 65-94.