Economic Growth and Convergence across the OIC Countries: An Econometric Framework

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Contents

1. Introduction

There has been considerable empirical work on cross-country growth for the last two decades. On the one hand, there were studies done on the basis of pre-existing models of growth in the tradition of Solow (1956), Cass (1965), and Koopmans (1965) and, on the other hand, some others were done along with the emergence of endogenous growth theories, including but not limited to, Uzawa (1965), Romer (1986) and Lucas (1988).

The first group of economists claims that without conditioning on any other characteristics of economies, the lower the initial level of real per capita gross domestic product (GDP) the higher is the predicted growth rate. This is referred to as *absolute convergence*. The main idea is that poor countries tend to grow faster per capita than rich ones. However, if the heterogeneity is allowed across the economies, or to put it differently, if countries differ in various respects - propensities to save, willingness to work, higher access to foreign markets- and if these respects are controlled for, then the convergence applies only in a conditional sense. This concept is called *conditional convergence* meaning convergence after differences in the steady states across countries are controlled for. The main idea is that an economy grows faster, the further it is away from its own steady-state (long-run) value[1] and, hence, in looking for convergence in a cross-country framework, it is necessary to control for the differences in steady-states of different countries (Islam, 1995).

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[1] Barro and Sala-i Martin (2004) defines steady-state as a situation in which the various quantities grow at constant (perhaps zero) rates.

A more explicit formulation of the concept of conditional convergence is found in Mankiw, Romer and Weil (1992), henceforth MRW, and this paper is based on that study, which is accepted as a milestone for the empirical cross-country growth literature. In brief, MRW performed an empirical evaluation of a Solow (1956) growth model using a multi-country dataset for the period 1960-1985. They found support for the Solow model's predictions by the inclusion of saving and population growth rate variables in the regression. Furthermore, they considered an augmented version of the Solow model by adding human capital as a factor of production, and ended up with strong evidence for conditional convergence.

The main purpose of this paper is to investigate whether there is a tendency for regional convergence among OIC countries[2]. The determinants of growth are also examined in this manner. Such an analysis requires econometric framework for two reasons. First, econometric framework will allow us to estimate to which extent the various explanatory variables (such as population, investment, human capital, inflation and etc.) can affect the growth. Second, in order to analyze the determinants of growth, graphical representation, alone, may be misleading. The relation can easily be driven by a few outliers on the graph. It is, therefore, crucial to support graphical representation of the data by econometric framework.

2. Data

Our sample comprises 31 OIC countries covering the period 1980-2009. Following the leading studies in the literature, including but not limited to MRW, Bernanke and Gurkaynak (2001), the oil producing OIC countries are excluded from the study, as the bulk of recorded GDP for these countries represent extraction of existing resources (oil and gas). It is, therefore, not rational to expect standard growth models to account for measured GDP in these countries[3].

The per capita income and population data are taken from World Bank World Development Indicators (WDI) dataset. The share of investment in GDP (investment ratio) and the inflation rate are obtained from the International Monetary Fund (IMF) World Economic Outlook dataset. Secondary enrolment rates including the female and male secondary schooling rates are obtained from United Nations Educational, Scientific and Cultural Organization (UNESCO) dataset. Rule of law index is obtained from World Bank Worldwide Governance Indicators. Finally, the share of intra-OIC exports

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[2] See Bagci (2012), for the existing income disparity among the OIC countries.
[3] Bahrain, Gabon, Iran, Iraq, Kuwait, Oman, Saudi Arabia and United Arab Emirates are excluded on this basis.

in total exports of countries is taken from Basic Social and Economic Indicators (BASEIND) database of SESRIC.

3. Methodology

This study employs country-level data available for 31 OIC countries. Following MRW and the other leading studies in the literature, income convergence in the OIC countries is estimated by using ordinary least squares (OLS) method. For this purpose, two income convergence models are employed: (i) Absolute Income Convergence; (ii) Conditional Income Convergence.

A univariate β-convergence model is estimated to determine if there is absolute convergence over the sample period with the following equation:

$$ln\left(\frac{y_{i,t}}{y_{i,t-1}}\right) = \alpha + \beta_0\left(lny_{i,t-1}\right) + \varepsilon \qquad (1)$$

where α is a constant, β_0 is a coefficient vector, y_t denotes the average per capita income of country i in year t, ln is the natural logarithm, $t-1$ is the initial year and ε is the error term.

The conditional income convergence model is estimated as follows:

$$ln\left(\frac{y_{i,t}}{y_{i,t-1}}\right) = \alpha + \beta_0\left(lny_{i,t-1}\right) + \mu_i\left(X_{i,t}\right) + \varepsilon \qquad (2)$$

where α is a constant, β_0 is a coefficient vector, y_t denotes the average per capita income of country i in year t, ln is the natural logarithm, $t-1$ is the initial year, $X_{i,t}$ indicates the explanatory variables, μ_i is a vector of μ_i parameters, and ε is the error term.

4. Absolute Convergence

The regression in the first column of Table 1 represents the results of the absolute convergence model to determine if there has been absolute income convergence over the period under consideration. Even though the convergence coefficient is negative (-0.002) and indicating convergence of per capita incomes across the countries, it is statistically insignificant. The model is also insignificant (Prob>F) and able to explain only 3 per cent of the total variation, which indicates that growth may be conditional and convergence can be explained by incorporating other factors that control for the differences in the long-run values. Indeed, this is not an unexpected outcome. As Barro (1991) concludes the hypothesis that poor countries tend to grow faster than rich countries seems to

be inconsistent with cross-country evidence, which indicates that per capita growth rates have little correlation with the starting level of per capita product.

Table 1. Regression Results for Absolute and Conditional Convergence		
Independent Variables		
Log(GDP)-1980	-0.002 (0.94)	-0.005** (2.58)
Log (Investment Ratio)		0.027*** (3.66)
Log (Population)		-0.010* (2.02)
Constant	0.025* (1.68)	-0.029 (1.29)
Observations	31	30
R-squared	0.03	0.41
Absolute value of t-statistics in parentheses ***significant at 15% level; ** significant at 5% level; *** significant at 1% level**		

5. Conditional Convergence under MRW Framework

As pointed out above, an alternative formulation of the standard β-convergence model has been to allow different economies to converge not to a common steady-state but to their own long-run income relativities. Such a concept is called conditional convergence since the convergence is conditional on the different structural characteristics of each economy such as propensities to save, willingness to work, higher access to foreign markets, and etc. Different structural characteristics imply that different countries will have different steady-state relative incomes.

The regression in the second column of Table 1, therefore, includes explanatory variables that are also used in MRW's paper. The explanatory variables added to the right hand-side of the regression are the rates of investment and population growth. The coefficient on the initial level of income is now significantly negative; that is, there is strong evidence of convergence. In addition, the inclusion of the rate of investment and population growth improves substantially the fit of the regression. The model now explains 41 per cent of the total variation.

For given values of investment and population growth rates, the neo-classical model predicts a negative coefficient on initial GDP that enters in the system in logarithmic form. The coefficient on the logarithm of initial GDP is interpreted as conditional rate of convergence. If investment and population growth rates are held constant, or to put it differently, if countries did not vary in their investment and population growth rates, then the economies tend to approach their long-run position

indicated by the magnitude of the coefficient (Barro, 1996). The estimated coefficient of -0.005 is highly significant and implies a conditional rate of convergence of 0.5 per cent per year. The rate of convergence is very slow in the sense that it would take the economies more than 100 years to get half way toward the long-run level of output. However, it should be noted that the inclusion of other explanatory variables, in addition to investment and population growth rates, in the next section will strengthen the tendency toward convergence.

6. Conditional Convergence and Determinants of Growth

Investment: Investment is a key element to economic growth. According to Blomstrom et al. (1993) fast economic growth does not take place without large investments in fixed capital. Levine and Renelt (1992) conclude that investment as a share of gross domestic product is the most robust explanatory variable of a country's growth. All in all, the empirical studies on growth indicate that the rate of capital formation determines the rate of a country's growth.

The estimated coefficient for the ratio of total investment to GDP is positive and statistically significant, 0.024. It is clear from Table 2 that investment is the most important element in promoting growth in OIC countries given the statistically significant and high coefficient value. OIC countries, therefore, are urged to invest a substantial portion of their GDP to grow faster.

Human Capital: Education is considered as a major contributing factor to sustainable growth and poverty alleviation. For this purpose, the measure of human capital will be added to the right hand-side of the regression. Following the leading studies in the literature, human capital is proxied by the log of the secondary school enrolment rate. The estimated equation is essentially same as that estimated in MRW. A higher school enrolment indicates a higher accumulation of human capital. Therefore, a higher enrolment rate may lead to higher economic growth, if higher human capital means higher economic growth. First column of Table 2 reports the regression results. Inclusion of a proxy for human capital further improved the fit of the model, particularly the significance level of the negative coefficient of initial GDP compared to Table 1.

Notably, the results show a significantly positive effect of enrolment rate on growth. On average, 1 per cent increase in secondary school enrolment rate is estimated to raise the growth rate by almost 1 per cent per year.

Furthermore, in order to analyze to which extent gender inequality in education may affect growth, secondary school enrolment rate will be replaced by male secondary schooling and female secondary schooling, respectively. As shown in the second column of Table 2, male secondary schooling has a significant effect; the estimated coefficient is 0.011 which indicates that, on average, 1 per cent increase in male secondary schooling is estimated to raise the growth rate by 1.1 per cent per year. Similarly, if the same approach is being employed for female schooling, then the estimated coefficient of this variable is 0.01 representing that, 1 per cent increase in female secondary schooling is estimated to raise the growth rate by 1 per cent per year.

Table 2. Regression Results for Conditional Convergence and Growth under MRW Framework				
Independent Variables				
Log(GDP)-1980	-0.008*** (3.53)	-0.009*** (3.40)	-0.011*** (3.78)	-0.010*** (3.78)
Log (Investment Ratio)	0.024*** (3.39)	0.024*** (3.44)	0.022*** (3.16)	0.021*** (2.94)
Log (Population)	-0.007 (1.36)	-0.006 (1.30)	-0.005 (0.95)	
Log (Enrolment Rate)	0.008** (2.20)			
Log (Male-Enrolment Rate)		0.011** (2.09)		
Log (Female Enrolment Rate)			0.010** (2.57)	0.010*** (2.91)
Constant	-0.026 (1.26)	-0.036* (1.67)	-0.014 (0.68)	-0.017 (0.79)
Observations	30	30	30	31
R-Squared	0.51	0.50	0.54	0.48
Absolute value of t-statistics in parentheses *significant at 15% level; ** significant at 5% level; *** significant at 1% level				

However, before concluding that female education is also a key factor to economic growth, it should be noted that female education not only enables women to engage in healthier habits and growing their children up in health ways but is also crucial to the reduction of fertility rates and, thus, population growth (Dauda, 2013). It is, therefore, not surprising to expect that female education would spur per capita income growth by lowering fertility, and this effect is not captured in regressions showed in Table 2 as the fertility rate is already held constant. Thus, if the fertility rate, which is proxied as the rate of population growth in this study, is omitted from the regression as shown in the fourth column of Table 2, then the estimated coefficient on female schooling (the level of female schooling that affects population growth inversely) is, again, 0.01 which implies strong

evidence that female education enhances economic growth through only the indirect channel of lowering fertility, which is in parallel to the findings of Barro (1996).

7. Inclusion of Other Explanatory Variables and Re-Evaluation of Convergence Coefficient

Before proceeding to interpreting the effects of other variables on growth, the estimated coefficient of rate of convergence will be re-evaluated since the regression includes more explanatory variables. If countries in the sample did not vary in all these explanatory variables, the estimated coefficient on the log of initial GDP is -0.013 that is highly significant (Table 3). It also implies a conditional rate of convergence of 1.3 per cent per year. Despite the strength on tendency toward convergence by the inclusion of more explanatory variables, it would still take economies almost 55 years to get half way toward steady-state level of output. Inclusion of all other variables increased R-square; 72 per cent of the cross-country variation is explained.

Rule of Law: World Bank defines rule of law as a parameter that captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement -implying the institutional quality-, property rights, the police, and the courts, as well as the likelihood of crime and violence. The rule of law index ranges from approximately -2.5 (weak) to 2.5 (strong) governance performance. It has been stressed in the literature that countries hold better governance performance will invest more which, in turn, lead to higher growth rates. The rule of law variable, included in the regression reported in the first column of Table 3, has a significantly positive coefficient, 0.007. It is evident that greater maintenance of the rule of law is favorable to growth.

Intra-OIC Trade: The connection between trade and growth is still an open-ended question. While some studies in the literature found a positive relationship between trade and growth, others doubt the robustness of this impact. However, especially for the developing countries, trade is found to be significantly and positively correlated with growth. More generally, trade volumes provide substantial support for the hypothesis that trade promotes growth through a number of channels.

Trade variable in our study is measured by the ratio of intra-OIC exports plus intra-OIC imports to GDP of each country in order to be able to analyze whether a higher increase in the intra-OIC trade compared to overall trade level of the countries will lead to higher growth rates. The

results in Table 3 show a significantly positive coefficient on the terms of trade: 0.005 which implies that an improvement in the terms of trade does stimulate an expansion of domestic output.

Table 3. Regression Results with the Other Explanatory Variables	
Independent Variables	
Log(GDP)-1980	-0.013*** (5.38)
Log (Enrolment Rate)	0.003 (1.05)
Log (Investment Ratio)	0.017*** (2.77)
Log (Population)	-0.035*** (3.53)
Rule of Law Index	0.007* (1.53)
Inflation	0.0001 (1.08)
Terms of trade	0.006** (2.18)
Constant	0.074* (1.99)
Observations	31
R-Squared	0.72
Absolute value of t-statistics in parentheses ***significant at 15% level; ** significant at 5% level; *** significant at 1% level**	

Inflation: Macroeconomic instability can cause damaging impacts on living standards. High inflation, unsustainable debt levels, large swings in economic activity, and volatility in exchange rates and financial markets can all contribute to job losses and increasing poverty and therefore lead to a contraction in a country's growth. Maintaining macroeconomic stability therefore is required for sustained and inclusive development (UN, 2012). Inflation rate is the most common variable used as an indicator of macroeconomic stability and it is usually found that inflation harms economic growth.

The inflation variable in our equation is the average rate of consumer prices during the period under consideration. The estimated coefficient is not significantly different from zero. Thus, there is only slight evidence that growth is negatively related with inflation in our sample.

8. Conclusion

This study investigated whether the OIC countries show a tendency for regional convergence during the last three decade. The determinants of growth were also examined in this manner. Considered together the results have several implications.

First, the empirical findings of this study documents the existence of conditional convergence which means that an economy grows faster; the further it is away from its own steady-state (long-run) value. This phenomenon shows up clearly for the OIC countries from 1980 to 2009. Initially, the convergence framework is examined under MRW framework. In this case, human capital is included in the model and 50 per cent of the cross-country variation in income per capita is explained. The rate of convergence is 0.5 per cent per year. Thereafter, more explanatory variables are included. Employing new variables improved substantially the fit of the regression and 71 per cent of the total variation was explained. In addition, it further lowered the coefficient on initial GDP and the rate of conditional convergence was calculated as 1.3 per cent per year indicating that it would take OIC economies almost 55 years to get half way toward steady-state (long-run) level of output. Such a period is very long compared to the textbook Solow growth model[4].

Second, in parallel with the findings of the previous empirical studies in the literature, investment and human capital are the important determinants of growth for OIC countries as well. Our results suggest that high investment rates and high levels of enrolment rate are directly growth enhancing. However, female education enhances economic growth through only the indirect channel of lowering fertility.

Third, the results conclude that a higher increase in the intra-OIC trade compared to overall trade level of the countries appears to be growth-inducing. It is, therefore, important for member countries to not only strive for higher trade but also push for strengthening trade relations among them. In this context, the system of most-favored nation status can be adopted.

Fourth, the results indicate that the rate of growth of population is unfavorable to growth if an equivalent portion of the economies' investment is not used to provide capital for the new workers. According to Becker and Barro (1988) another approach is that a higher rate of growth of population will require the resources to be devoted to childrearing rather than producing of goods.

Last but not least, institutional quality is also an important element of economic growth. Our results indicate that countries with better institutions and property rights grow faster. Therefore, OIC countries are urged to give priority to improve the quality of their institutions which, in turn, will enable them to invest more in physical and human capital and stimulate growth.

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[4] Such an outcome is not surprising and is in line with the previous empirical studies in the literature.

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