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POPULATION AND ECONOMIC GROWTH IN DEVELOPING COUNTRIES

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ABSTRACT

Purpose: This paper examines the economic effects of the demographic transition in developing countries.
Findings: Based on data from the World Bank and using a sample of forty-three developing economies, we find that the growth rate of per capita GDP is linearly dependent upon population growth, both the young and old dependency ratios, the mortality rate, and whether or not the rate of population growth is less than 1.2 percent per year. Using interaction variables in light of the severe degree of multicollinearity among explanatory variables, we find that per capita GDP growth linearly depends on population growth, the old dependency ratio, the mortality rate, and the interactions between population growth and both the young and old dependency ratios, between population growth and whether or not the rate of population growth is less than 1.2 percent per year, and the interaction term between the young dependency ratio and whether or not the rate of population growth is less than 1.2 percent per year.
Practical Implications: Statistical results of such an empirical examination will assist governments in devising policies aimed at influencing the economic effects of the demographic transition..
Methodology/Approach: Data for all variables are from the *2010 World Development Indicators.* We apply the least-squares estimation technique in a multivariate linear regression. We also test for the nonlinear effect of population growth on economic growth and note that the introduction of interaction terms between population growth and dependency ratios as well as those between whether or not the population growth rate is less than 1.2 percent and population growth and the young dependency ratio yields better statistical results.

JEL Classifications: O12, O15, O50
Keywords: Demographic Transition, Mortality Decline, Population Growth, Dependency Ratios, Developing Countries

INTRODUCTION

Economists have often neglected the impact of fundamental demographic processes on economic growth. Bloom and Canning (2001) are among the few who explore the effect of the demographic transition on economic growth. They argue that it is possible that the interaction of economic growth with population dynamics can result in a poverty trap. Consider two clubs: one with low income and high population growth rates, while the other with high income and low population growth rates. While transition between these clubs may be rare, they are able to show that when it does happen, it does so very quickly, due to the positive feedbacks between growth and the demographic transition. More recently, Dyson (2010) claims that mortality decline aids economic growth and hence leads to an increase in the standard of living. As people live longer, they tend to think more about the future and are more likely to take risk and innovate. For instance, Bloom and Canning (2001) and Kalemli-Ozcan (2002) find evidence in developing countries that mortality decline has the tendency to raise educational attainment and savings rates and thus to increase investment in both physical and human capital.

Mortality decline is also accompanied by health gains that in turn enhance people's economic productivity. Strauss and Thomas (1998), for instance, show that healthier workers are likely to be more productive.

In addition to mortality decline, Dyson (2010) has identified population growth, fertility and age-structural change as well as urban growth/urbanization as demographic factors that affect economic growth. The present study empirically examines the impact of the various dimensions of the demographic transition on per capita GDP growth in developing countries. Statistical results of such empirical examination will assist governments in those countries devise policies aimed at influencing the economic effects of the demographic transition. Taking into consideration the two-way causality between the dimensions of the transition, we include interaction variables in order to eliminate the simultaneity bias and thus are able to obtain superior statistical results.

This paper is organized as follows. In the next section, a selected review of the literature on the economic effects of the demographic transition is given. This is followed by the formulation of a statistical model to be estimated. Theoretical underpinnings for the inclusion of explanatory variables are included in this section. Statistical results are reported in the subsequent section. A final section gives concluding remarks as well as policy recommendations.

A SELECTED REVIEW OF THE LITERATURE

While Dyson (2010) contends that mortality decline is the chief cause of economic development, McKeown (1976) argues that the direction of causality should be reversed, i.e., it is the improvement in the standard of living that results in lower death rates. Easterlin (1996) and Schofield and Reher (1991) also show that the dire living conditions that came with the industrial revolution and modern economic growth in cities of Europe during the nineteenth century might have raised mortality rates. On the other hand, evidence from contemporary developing economies tends to show that it is mortality decline that leads to economic growth, as it increases investment in both physical and human capital via increased savings rates and education (see, for instance Bloom and Canning (2001) and Kalemli-Ozcan (2002).

Furthermore, mortality tends to fall as a result of declines in death rates from infectious diseases. Declines in these diseases tend to bring about an improvement in the nutritional status of children which in turn leads to a fitter future labor force. In fact, Strauss and Thomas (1998) show that healthier workers tend to be more productive.

In pre-transitional societies, relatively rapid population growth almost always resulted in a fall in the standard of living due to the rather severe limits to the technical progress in agriculture or to the fixed supply of land, as pointed out by Malthus (1798; 1830 [1970]). This prompts Clark (2007) to state that income levels before the nineteenth century could not escape the Malthusian equilibrium due to the very low rate of technological advance in all economies.

However, according to the 'neutralist' or 'revisionist' view, high population growth rates in developing countries since the middle of the twentieth century have had little effect on per capita GDP growth (see, for instance, Kuznets (1967), Kelley (1988), and Kelley and McGreevey (1994)). Simon (1981, 1989) would go as far as suggesting that population growth may have had a positive impact on per capita GDP growth in the long run through improvement of productivity through the contribution of new ideas and the learning-by-doing resulting from increased production volume. Nevertheless, the current consensus is that, as more data become available, rapid population growth has exerted a significant negative effect on economic growth in developing countries (see, for example Birdsall and Sinding (2001), Barro and Sala-i-Martin (2004), Sachs (2008), and Headey and Hodge (2009)).

The recent experience of fertility decline in developing countries in Asia and Latin America has reduced a country's dependency ratio, which then raised the potential for faster economic growth through higher saving and investment levels in both physical capital (such as roads, production facilities) and human capital (such as higher educational attainment and training for each young worker), particularly for an extended period over which the labor force increases at a faster rate than the pool of dependent people (see, for instance, Higgins and Williamson (1997), Mason (1997), and Bloom and Canning (2001).

Due to this decline, however, eventually this region will experience an increase in its old-age dependency ratio as is the case for both Europe and Japan (see, for instance, Bloom et al. (2009)). Population ageing thus may be exercising a negative impact on economic growth.

While many problems such as congestion, pollution, and slum settlements are caused by urban growth in contemporary developing countries, cities are often described as 'engines' of growth (see, for example, Jacobs (1972), Crook (1997), and Beall and Fox (2009)). Cities also provide large and concentrated markets, allowing for economies of scale in the production of manufactured goods as well as low transportation costs. It is in urban areas that firms can better match their labor demands with the supply of skills, while the returns to infrastructure such as roads, port facilities, and electricity grids are greater due to the concentration of industries and firms. Fox and Dyson (2008) analyze international data for the period since 1975 and find that urban growth has been positively associated with per capita GDP growth.

Building upon the idea that the demographic transition is responsible for economic growth, in this paper we wish to empirically analyze the effect of the various dimensions of this transition on per capita GDP growth using a sample of forty-three developing countries [1]. We hypothesize that per capita GDP growth in a developing country is a function of the following factors: the level of urbanization, urban growth, population growth, population growth squared [2], both the young and old dependency ratios, the mortality rate, the total fertility rate, and whether population growth rate is below 1.2 percent annually [3]. To allow for the joint causation between the various dimensions of the demographic transition we include interaction variables and expect superior econometric results.

THE STATISTICAL MODEL

Assuming that various exogenous [4] factors affect per capita GDP growth in a developing country, we can state the following statistical model:

$$Pgdp = \beta_0 + \underset{(+)}{\beta_1 URBAN} + \underset{(+)}{\beta_2 urb} + \underset{(+)}{\beta_3 pop} + \underset{(-)}{\beta_4 pop^2} + \underset{(-)}{\beta_5 young} + \underset{(-)}{\beta_6 old} + \underset{(-)}{\beta_7 mortality} + \underset{(-)}{\beta_8 TFR} + \underset{(+)}{\beta_9 pop{<}1.2} + \varepsilon \qquad (1)$$

where *Pgdp* = Per capita GDP growth rate, 2007-2008.
URBAN = Urban population as a percent of total population, in 1990.
urb = Average annual growth rate of the urban population, 1990-2008.
pop = Average annual population growth rate, 1990-2008.
young = Young people as a percent of working-age population, in 2008.
old = Old people as a percent of working-age population, in 2008.
mortality = Crude death rate, per 1,000 people, in 2008.
TFR = Total fertility rate, in number of births per woman, in 1990.
pop<1.2 = Dummy variable, taking on the value of 1 if the country's average annual growth rate is below 1.2 and 0, otherwise.

It is important to note that in very poor countries such as Côte d'Ivoire, Democratic Republic of Congo, Ethiopia, Kenya, Madagascar, Nigeria, Pakistan, Sudan, Uganda, Tanzania, and Yemen, agriculture still accounts for a significant part of the overall economy and it continues to be very hard to increase agricultural productivity at rates that are faster than those of population growth. In addition, rapid population growth adds to environmental degradation such as soil erosion, water pollution, falling water tables, loss of fuel wood, and deforestation, which in turn almost always has a negative impact of the well-being of poor people living in rural areas. As a result, we expect the coefficient estimate of the population growth variable to have a negative sign.

A second dimension of the demographic transition is the decline in the fertility rate. Initially, this decline causes a decrease in the fraction of the population who are aged less than 15 years. Eventually, however, this process will lead to an increase in the proportion of the population who are 65 years and above. Thus, a fall in the fertility rate first causes a decline in the overall dependency ratio which will be followed by an increase in this ratio as population ageing sets in. As a result, we suspect that this independent variable will be strongly correlated with both the young and old dependency ratios. We hypothesize that for developing countries that experience a recent decline in the total fertility rate, their dependency ratio is reduced and thus will grow faster whereas for those countries who have gone through this decline for quite some time, their dependency ratio is increased and hence will experience slower economic growth.

It is thus important to note that countries that go through this stage of the demographic transition, namely fertility decline, have a narrow window of opportunity to better themselves economically. This would be the case for countries such as China, Indonesia, South Korea, Thailand, and Vietnam in the period since the 1970s. This fact may also explain why there exists a negative association between economic growth and population growth as some countries have been able to take advantage of this opportunity to increase per capita GDP growth while reducing population growth.

Moreover, there is considerable evidence that fertility decline results in improvement in children's health in terms of food consumption and nutritional status as well as their education. These improvements coupled with women's increased participation in the formal labor force lead to faster economic growth, with a lag.

In a developing country where there is a high young dependency ratio, more resources will be devoted to the rearing of children. On the other hand, more time and effort will be devoted to the caring of elderly people in an ageing developing country. Since it is less likely that children are capable of taking care of themselves, while one could expect many older people to stay healthy on their own and to even work at a later age, we expect the coefficient estimate on the young dependency ratio to have a negative sign, while the sign of that on the old dependency ratio may be ambiguous.

In addition to the reasons mentioned above for which the process of urbanization and urban growth contribute positively to economic growth, urbanites are more likely to have better access to modern healthcare, education, water and sanitation. They are more likely to have a longer life expectancy and more secure food supplies even though there may be instances in which they may suffer from food shortages and famines. Fox and Dyson (2008) analyze international data for the period since 1975 and find that the growth in the share of the urban population has been positively related to per capita income growth. However, Brockerhoff and Brennan (1998) find that since the late 1970s the survival advantage of urban residents in Latin America and the Caribbean has decreased and stopped by the earlier 1990s. Massey (1996) also shows that urbanization has resulted in a geographic concentration of affluence and poverty throughout the world. This in turn will lead to a deeply polarized and increasingly violent world. Nevertheless, the net effect of urban growth and urbanization on economic growth is probably positive. We thus expect the higher the rate of urban growth and the higher the level of urbanization, the higher the per capita GDP growth rate.

To account for the two-way causality between the various dimensions of the demographic transition, we choose to include interaction variables in order to eliminate the simultaneity bias and thus expect to obtain superior statistical results.

Data for all variables are from the *2010 World Development Indicators.*

EMPIRICAL RESULTS

Table 1 gives least-squares estimates of regression coefficients in equation *(1)* for a sample of forty-three developing countries. The goodness of fit of the model to the data is reasonably good as indicated by the value of 0.297 of the adjusted coefficient of determination. We observe that only four variables are statistically significant at the 5 percent level. As expected, due to multicollinearity among independent variables, the

Table 1. Dependent variable: Per capita GDP Growth (No Interaction Variables)

	Coefficient Estimates	*t-Statistics*
Intercept	8.768	1.538
URBAN	-0.0001	-0.005
urb	0.321	0.692
pop	-6.805	-1.900*
pop^2	-0.295	-0.506
young	0.204	2.458**
old	-0.493	-1.346
mortality	-0.302	-1.955*
TFR	0.751	1.018
pop<1.2	3.589	2.204*

Adjusted R^2 = 0.297

*Significant at the 5 percent level.
**Significant at the 1 percent level.

coefficient estimates on the young dependency ratio and total fertility rate do not have the expected negative sign.

All else equal, a one-percentage point decline in the average annual population growth rate is expected to lead to a 6.81 percentage point increase in per capita GDP growth. We also note that the square of the average annual population growth rate does not have an effect on per capita GDP growth, suggesting that the impact of this variable is linear. On the other hand, a one-death per 1,000 people decrease is expected to result in an increase of 0.31 percentage point in per capita GDP growth, ceteris paribus. We also expect developing countries in which the average annual population growth rate is less than 1.2 percent to have per capita GDP growth rates that are 3.6 percentage points higher, all else equal.

A backward elimination stepwise method was applied to arrive at a revised model, the regression results of which are reported in Table 2. The goodness of fit of the

Table 2. Dependent variable: Per capita GDP Growth (Revised Model)

	Coefficient Estimates	*t-Statistics*
Intercept	11.711	3.788
pop	-6.913	-3.643**
young	0.224	3.320**
old	-0.600	-2.753**
mortality	-0.285	-2.076*
pop<1.2	3.392	2.514**

Adjusted R^2 = 0.339

*Significant at the 5 percent level.
**Significant at the 1 percent level.

model is better as indicated by the higher value of 0.339 of the adjusted coefficient of determination. We observe that all five independent variables are statistically significant at the 5 percent or lower level. The coefficient estimate on the young dependency ratio continues to have the unexpected negative sign, while the estimates on the remaining four explanatory variables do have their expected sign. Qualitatively the results are similar to those obtained in the original regression. All else equal, as the old dependency ratio increases by one percentage point, we would expect per capita GDP growth to decline by 0.6 percentage point.

We assess the extent of the multicollinearity problem by reporting the sample correlation coefficient matrix in Table 3. We observe that countries with high population growth rates tend to have a higher young dependency ratio and a lower old dependency ratio and are less likely to have average annual population growth rates below 1.2 percent. We also note that countries with high young dependency ratios tend to have low old dependency ratios, higher mortality rates, and are less likely to have average annual population growth rates below 1.2 percent, while countries with high old dependency ratios tend to have average annual population growth rates below 1.2 percent.

Table 3. Sample Correlation Coefficient Matrix

	pop	*young*	*old*	*mortality*	*pop<1.2*
pop	1				
young	0.919	1			
	14.958				
old	-0.902	-0.734	1		
	-13.373	**-6.929**			
mortality	0.033	0.339	0.170	1	
	0.211	**2.305**	1.106		
pop<1.2	-0.756	-0.614	0.794	0.206	1
	-7.391	**-4.980**	**8.362**	1.347	

Note: Bold t-statistics imply statistical significance at the 10 percent or lower level.

Table 4 presents regression results when interaction variables are included in the model examining the economic effects of the demographic transition. We note that the goodness of fit of the model to the data is reasonably good as indicated by the value of 0.307 of the adjusted coefficient of determination. We observe that only two variables are statistically significant at the 5 percent level. Population growth continues to exert a negative impact on per capita GDP growth while the interaction term between population growth and whether the population growth rate is below 1.2 percent also has a negative effect on economic growth.

Table 4. Dependent variable: Per Capita GDP Growth (With Interaction Variables)

	Coefficient Estimates	t-Statistics
Intercept	33.543	1.528
pop	-14.638	-2.494*
young	-0.113	-0.244
old	-2.298	-1.288
mortality	-0.337	-0.818
pop<1.2	-4.085	-0.345
popyoung	0.088	1.055
popold	0.655	1.182
poppop<1.2	-15.596	-1.833**
youngold	0.013	0.297
youngmortality	0.001	0.154
youngpop<1.2	0.566	1.612
oldpop<1.2	0.403	0.526

Adjusted R^2 = 0.307

*Significant at the 5 percent level.
**Significant ate the 1 percent level.

Table 5. Dependent variable: Per Capita GDP Growth (Revised Model with Interaction Variables)

	Coefficient Estimates	t-Statistics
Intercept	25.596	4.872
pop	-13.732	-4.157**
old	-1.604	-3.853**
mortality	-0.261	-2.007*
popyoung	0.074	3.350**
popold	0.757	2.934**
poppop<1.2	-17.050	-2.508**
youngpop<1.2	0.604	2.780**

Adjusted R^2 = 0.397
*Significant at the 5 percent level.
**Significant at the 1 percent level.

We again apply the backward elimination stepwise method to arrive at a revised model, the regression results of which are reported in Table 5. The goodness of fit of the model improves as shown by the higher value of 0. 397 of the adjusted coefficient of determination. We observe that all variables are statistically significant at the 5 percent level or lower. As interaction terms between population growth and both dependency ratios as well as that between population growth and whether the average annual population growth rate is below 1.2 percent are introduced, the negative impact of population growth on per capita GDP growth is stronger. All else equal, a one-percentage point decrease in population growth is expected to lead to an increase of 13.7 percentage points in per capita GDP growth rate. Similarly, a one-percentage point increase in the old dependency ratio is likely to result in a decline of 1.6 percentage points in per capita GDP growth, ceteris paribus. Since there is no interaction between the mortality rate and other dimensions of the demographic transition, the magnitude of the negative impact of this variable on economic growth remains pretty much the same.

We find that while the young dependency ratio in itself does not affect per capita GDP growth, its interaction with population growth exerts a positive impact on economic growth. This is also true of the positive effect on growth of the interaction between population growth and the old dependency ratio. We also observe that there is a negative effect of population growth on per capita GDP growth in developing countries with average annual population growth rates less than 1.2 percent. On the other hand, developing countries with high young dependency ratios and low population growth rates (less than 1.2 percent annually) tend to grow faster, other things being equal.

CONCLUSION

In this paper we use a statistical model and data from a sample of forty-three developing economies to empirically analyze the impact of several dimensions of the demographic transition on per capita GDP growth. We observe that the results are more robust when interactive variables are included in the model. We are able to draw the following conclusions:

1. The effect of population growth on per capita GDP growth is linear and everywhere negative. It is stronger when interaction terms are included in the statistical model. Governments in developing countries can influence population growth in order to stimulate growth. China provides a clear example by suddenly introducing a collection of highly coercive methods to reduce the total fertility rate from about 5.8 to 2.2 births per woman between 1970 and 1980.
2. Since a decline in fertility affects the age structure of the population of a developing country, it is found to have no significant statistical impact on economic growth when both the young and old dependency ratios are included in the model. The effect of the old dependency ratio on per capita GDP growth is always negative and stronger when interaction terms are included in the model.
3. On the other hand, the interactions between the young dependency ratio and population growth and whether or not the average annual population growth rate is less than 1.2 percent exert a positive influence on economic growth.

4. Neither the level of urbanization nor urban growth has a statistically significant impact on per capita GDP growth. This result may be due to the fact that these two dimensions of the demographic transition exert positive and negative effects on economic growth and these effects are self-cancelling.

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