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Policy Priorities to Reduce Excessive Rate of Population Growth in Underdeveloped Countries

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Abstract : This study addresses one of the most important policy issues for underdeveloped countries: what are the factors which must be addressed, when designing effective policy to reduce excessive rate of population growth. We introduce quantitative model based on cross-national data in order to find out what are the most important variables associated with population growth. The model is based on Soft Regression (SR) method. This method is based on Fuzzy Information Processing and Heuristic approach. In contrast to traditional statistical regression methods, it does not require restrictive conditions (which often contradict the "real world" conditions), and thus avoids computational distortions when such conditions are violated. It allows us to include in the model all the relevant explanatory variables without losing some variables due to multi-collinearity problem. Moreover, SR method performs reliable computation of relative importance of the explanatory variables, which is a very helpful feature for determining policy priorities.
The main conclusion of this study is: Secondary and Tertiary Education enrollment variables are the most important policy variables to reduce excessive rate of population growth.
JEL classification:C21, J10, O20.

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I. BACKGROUND

It is desirable for the underdeveloped economies to attempt to lower the pace of the natural growth rate of their population (in particular for countries where such a growth is excessively high). The reason is: the only way to increase standard of living is by increasing aggregate income faster than the rate of increase of population. Therefore, it is necessary to attain a sustainable increase in aggregate income that is sufficiently larger in comparison to the rate of population growth, in order to gradually diminish the standard of living gap versus developed countries. Hence, when the rate of population growth is high it requires to attain and to maintain very rapid economic growth rate on a sustainable basis for decades. However, such an exceptional economic performance has been extremely unusual historically, and is difficult to achieve by most underdeveloped economies for reasons explained below.

1. Large majority of underdeveloped economies (characterized by a very rapid rate of natural population increase) rely to a very large extend on traditional economic activities, associated with utilization of natural resources (including traditional agriculture, forestry, fishery, etc.), and critically depend on these natural resources. Such traditional economic activities when combined with rapid growth of population face the Law of Diminishing Marginal Returns and thus achieving a rapid long-term growth of aggregate economic activities becomes unfeasible.
2. Underdeveloped economies usually rely on primary commodities for exports. There have been many cases of underdeveloped economies displaying impressive rates of growth over limited (in general) number of years due to favorable conditions in the relevant for them commodity markets. However, primary commodity markets are characterized by wide fluctuations of prices over the years and this fact complicates sustainable and rapid long-term economic growth. Decline of commodity prices in a major export market or markets generally leads to economic crisis, and when combined with a rapid population growth over an extended time period, further exacerbates the situation.

During the period of economic difficulties due to the Law of Diminishing Marginal Returns and/or unfavorable commodity markets, we expect the persisting rapid population growth to exert substantial stress on political system and social stability, and if such conditions persist long enough, they can lead to very severe consequences.

The policy aiming at reduction of such pace of population growth requires understanding the significant factors affecting population growth and their relative importance. We present a quantitative model based on variables that have been discussed in literature, and for which quantitative data are available. Our purpose is to provide policy makers with information regarding the most important factors associated with decreasing rapid natural population growth. To test the consistency of the results, we perform modeling for two years, 1985 and 2000.

We utilize quantitative technique of Soft Regression (SR), which is based on Artificial Intelligence methods including fuzzy information processing and heuristic information processing. This will contribute additional angle to the already diversified demographic research. There are some technical difficulties associated with quantitative modeling using conventional modeling techniques such as multivariate regression (MVR). For example, MVR can indicate which variables are significant and which are not, but there is no effective technique to find out the relative importance of various variables (Yosef and Shnaider, 2017), which is needed in order to set policy priorities. There are also additional limitations when using MVR (see details below). The method of SR does not require restrictive and often unrealistic conditions in order to generate reliable results. It allows us to compute relative importance of each of the explanatory variables utilized in the model, and to provide valuable information for policy makers regarding what variables are more important for setting policy priorities and to what extent.

Literature Survey

Most publications dealing with negative effect of rapid natural population growth on long- term economic performance are based on Malthus (1798). The supporters are claiming that despite over 200 years passed since he published his theory about the principle of population, it is still relevant, while others reject it on the basis that developed countries have escaped his pessimistic predictions.

Cincotta and Engelman (1997) claimed that despite lack of clear evidence in previous decades, the more recent data make it clear that during the 1980s, population growth dampened the growth of per capita gross domestic product, which is considered the primary measuring unit of economic growth. The negative effects of rapid population growth appear to have weighed most heavily on the poorest group of countries in the developing world during the 1980s and the 1990s. Declines in human fertility in the 1970s and 1980s almost certainly enhanced rapid economic growth during the 1980s and early 1990s in such East Asian economies as South Korea, Taiwan, Singapore, and Hong Kong. Shnaider and Haruvy (2008) conducted the study of background factors affecting the long-term economic performance. Their study utilized cross-national data for the year 1997. Among other findings, the study indicated significant negative relationship between the level of economic activity per capita representing standard of living and the rate of natural population growth. Ahituv (2001) presented empirical model of the interplay between fertility and economic development. Using panel data, his study found that a one-percent decrease in population growth increases GDP per capita growth by more than three percent. In addition, because families with low levels of human capital choose to have more children, income per capita grows faster in developed countries than in under-developed countries. Brander and Dowrick (1994) used a 107 country panel data set covering 1960-85, and found that high birth rates appeared to reduce economic growth. Most significantly, they found that birth rate declines had a strong medium-term positive impact on per capita income growth.

Sanches-Romero (2013) demonstrated, that when more detailed demographic information is used, the Computable General Equilibrium models and the Convergence Models generate similar results. They tend to produce different results when less detailed demographic information is included. He used Taiwan as a case study and demonstrated that Taiwan's demographic transition accounts for 22% of per capita output growth and 17.7 % of investment rate for the period 1965-2005. Chu et. al. (2013) presented a scale-invariant Schumpeterian growth model with endogenous fertility and human capital accumulation. The model features two engines of long-run economic growth: R&D-based innovation and human capital accumulation. One novelty of this study is endogenous fertility, which negatively affects the growth rate of human capital.

Barlow (1994) names Lagged Fertility as an important explanatory variable often omitted in analyzing rate of population growth and its relation versus standard of living. Soubbotina and Sheram (2000) refer to "demographic momentum" as a phenomenon when population continues to increase rapidly for some years after fertility rate drops. They postulate that demographic momentum is in particular significant in developing countries that had the highest fertility rates 20-30 years ago.

Bongaarts and Watkins (1996) described the general worldwide demographic trends for developing countries, and pointed to uneven decline in the rate of natural population growth of various regions. They mention factors such as industrialization, urbanization and increased education as possible explanations. Wilson (2001) analyzed the factors that have led to the convergence of demographic factors around the world, and presented relations of the world's population according to the levels of life expectancy and total fertility they experienced in the early 1950s, the late 1970s, and around 2000.

The method of Soft Regression (SR) which we use in our analysis is based on Fuzzy and Heuristic Information Processing (Kandel et. al., 2000; Maimon and Rokach, 2005). Comparison of SR to Multivariate Regression (MVR) appears in Yosef et. al (2015). The comparison of computing Relative Importance by utilizing SR versus traditional regression methods is presented in Yosef and Shnaider (2017)**.**
Hence, the literature refers to the following main factors affecting population growth: aggregate product(income) per capita, lagged and adolescent fertility, education, urbanization and life expectancy.

The model

Our objective in constructing the model is to find out which variables are insignificant, and therefore ineffective as policy targets, and which are significant and should be addressed by policy makers. In addition, in order to design affective policy approach, it is necessary to have reliable evaluation of the relative importance among the significant variables.

The dependent variable is Natural Population Growth calculated by Birth Rate minus Death Rate. We utilized the following variables as explanatory factors of our model, based on extensive demographic literature, as well as data availability in World Bank database.

Explanatory Variables

Based on the literature, variables that affect Natural Population Growth are: standard of living, economic and social progress, investment in human capital(education), lagged fertility rates and adolescent fertility. We use quantitative variables (including some proxy variables)according to availability of data by utilizing all the relevant demographic variables we could find in the data base of the World Bank. These variables include: economic activity per capita, education, lagged fertility, life expectancy, urbanization and adolescent fertility.

1. **Value of Economic Activity per capita.** It is represented by GDP (Gross Domestic Product) per capita and GNI (Gross National Income) per capita. These are different measurements representing <u>standard of living</u> by the value of economic activity per capita, and considered common and legitimate measurements. Some of these data series are in current U.S. dollars (USD), while others are in constant 1995 USD, in constant 2000 USD, and in constant 2005 USD. There are data series based on regular currency conversion method vs. PPP (purchasing power parity) conversion method. We decided to select the following two data series to represent economic activity per capita: GDP per capita, PPP (current international $); and, GNI per capita, PPP (current international $). This variable is expected to be inversely related to natural population growth.
2. **Education:** This is a proxy for investment in human capital and we decided to find out how different levels of education are related to the natural population growth. It is represented by the percentage of population enrolled in primary, secondary and tertiary education. Education variables are expected to be inversely related to natural population growth.

It is represented by three variables representing the percentage of population enrolled in the relevant educational institutions:

   a. **Tertiary Education:** Percentage of the relevant population group that is enrolled in tertiary education institutions.
   b. **Secondary Education**: Percentage of the relevant population group that is enrolled in secondary education institutions.
   c. **Primary Education**: Percentage of the relevant population group that is enrolled in primary education institutions. It is a proxy for literacy level.

Each one of the three variables representing Education factor, represents different degree of investment in human capital, which justifies including all of them in the model.

3. **Lagged Fertility Rate:** We expect lagged fertility rates to be directly related to the present natural population growth rate (Soubbotina and Sheram ,2000). We selected lag period of 20 years.
4. **Life Expectancy**: This variable is a proxy for higher <u>standard of living, quality of life and welfare</u> of the population. Therefore, it is expected to be inversely related to the dependent variable.
5. **Urbanization**: This variable, representing the degree of urbanization, is a proxy <u>for economic and social progress</u>. Hence, it is expected to be inversely related to natural population growth. It is measured as percentage of urban population vs total population of that country.
6. **Adolescent Fertility**: This variable is also a proxy (negative<u>) for economic and social progress.</u> It is expected to be directly related to natural population growth.

Data

We used cross-national data for the years 1985 and 2000, obtained from the World Bank data bases and hard copy reports. We excluded from the study all the countries with small populations (of half a million or less).

Additional countries were excluded due to missing data. The total of 109 countries were included in our study for year 1985, and 129 countries were included in year 2000.

Method

The above description of the explanatory variables points to a possibility that there is a mathematical correlation among some of the variables described above. This means that it becomes impossible to include all of them together in the model when utilizing traditional modeling tools such as MVR (Multi Variable Regression). Due to multicollinearity, some of the explanatory variables become insignificant not because they are not related enough to the dependent variable, but because of technical limitations of the MVR. We avoid this problem by utilizing SR (Soft Regression) modeling tool, where explanatory variables are not required to be independent of each other. Detailed mathematical description of Soft Regression as well as mathematical comparison of Soft Regression versus MVR appear in Yosef and Shnaider (2017) and Yosef et. al (2015).

Weaknesses of the traditional modeling tools such as MVR

In this section we present more detailed evaluation of some weaknesses of the traditional modeling tools such as MVR. The purpose of this analysis is to demonstrate why we have decided to utilize Soft Regression as our modeling tool for this study.

MVR is a modeling tool, and in the process of using it we distinguish between the important factors correlated with the variable we model and the unimportant factors. Modeling by definition is a process of simplification, where we attempt to simplify a complex reality and try to understand it by focusing only on the most important factors, while leaving unimportant factors out of the model, so that they will not obscure our ability to analyze and understand the most important things. Therefore, by definition, modeling involves a certain degree of imprecision, caused by the factors (supposedly unimportant)left out of the model.

The factors that are left out of the model are in reality still interacting with the dependent variable causing some variation in its behavior that the included explanatory variables cannot explain, and represent randomness. Randomness is supposed to cause minor deviations in the behavior of the depended variable versus its expected behavior based on the behavior of explanatory variables. This, of course, expected to be the case if the factors left out of the model are truly of minor importance and tend to cancel each other out over a large enough number of measurements. However, if for whatever reason one or more of the important factors influencing the dependent variable is/are left out, and is/are causing deviation in the expected behavior of the dependent variable, this is already not a randomness error (normal and expected statistical imprecision) but a modeling error causing mistaking results of large magnitude. It is termed "misspecification of model" and leads to biased, distorted results. Regular statistical tests cannot detect misspecification of the model. In some cases, model misspecification can be detected because the coefficients of explanatory variables appear with illogical signs (plus instead of minus or vice versa). However, in many cases models appear to be logical, signs of their coefficients appear to be correct and all the statistical tests look satisfactory; however, the model might still be misspecified. In this case we will discover the problem only when the model fails.

Model misspecification may occur due to incorrect set of the explanatory variables because we are not aware of some important factors influencing the behavior of dependent variable or if we cannot measure them. For example, in the literature survey above, we encountered factors such as modernization, industrialization etc., that can supposedly influence natural population growth. However, we did not find quantitative data for these variables.

Model misspecification may occur also due to incorrect functional form of the equation. In general we apply linear function because of convenience (assuming it is a close enough approximation of real behavior), and not because we have definite theoretical proof that the function is linear. If we decide to use non-linear specification, there is an infinite amount of possibilities and we do not know which is the correct one.

Additional factor for the model misspecification arises from purely technical reasons, since it is assumed that explanatory variables are independent of each other; However, in reality very often explanatory variables are highly correlated mathematically among themselves (even if logically they are unquestionably separate factors). This often causes either one or both of the correlated explanatory variables to appear as statistically insignificant, and therefore redundant (even though based on common sense, they should definitely be a part of the model in order to have correct model specification).

Hence, the modeling process raises many questions that are very difficult to answer positively. Do we know with certainty all the important factors that affect natural population growth? Are all of them measurable quantitatively and appear in statistical publications and data bases? Do we have any idea regarding the correct functional form of the equation? Are all the explanatory variables independent of each other?

In order to mitigate the uncertainty regarding the reliability of our results, we utilize another modeling tool SR (Soft Regression) which is not affected by the problems discussed above.

Soft Regression

Soft Regression (SR) is a modeling tool based on soft computing concepts such as Fuzzy Logic and Fuzzy Information Processing (Zadeh, 1965). The technical details of the SR method are described in Yosef et al. (2015) and in Yosef and Shnaider (2017). We briefly describe several of the important characteristics of the SR tool that are different from those of MVR, justifying its use in our study.

1. SR does not require precise model specification. This regression tool is based on Fuzzy Logic, which is designed in the first place to handle information under severe conditions of uncertainty and imprecision. . The idea is to give up the possibility of building a precise model, and get the opportunity to work with whatever data are available. We generate a partial/less precise model that could still be very reliable in its conclusions, because it avoids the problem of misspecification bias. In other words, it allows the user to utilize whatever partial and not very reliable data are available to generate some broad conclusions that are expected to be more reliable in comparison to more “precise” but misspecified MVR model based on the same data. Of course, in the case where some potentially important variables are excluded due to lack of data, the model is misspecified by definition.

2. Also, the relative importance of the variables is not affected by adding or removing variables. When a partial model is constructed(because we are not sure whether all the important factors are included), the significance of the explanatory variables and the relative importance of those variables among themselves are not affected by adding additional variables to the model, or removing some variables from it. This is in contrast to the behavior of MVR, where addition or removal of an explanatory variable can change drastically the significance of other explanatory variables of the model. This characteristic of the SR adds an important feature of stability to the research.

Next we explain some terms that appear in the results presented in this study:

1. **Similarity**: Denoted S_{Y,X_j} and ranges between 0 and 1.

In the Soft Regression method we utilize the measure of similarity which indicates the degree to which explanatory variable behaves in a similar pattern, whether direct or inverse, in comparison to dependent variable.

Therefore, the measure of similarity S_{Y,X_j} is an equivalent to the statistical measures of significance (t-tests or sig.). Significant relation is found with similarity levels of $S_{Y,X_j} \geq 0.8$.However, in addition to significant relation, there is an option of partial significance $0.7 < S_{Y,X_j} < 0.8$,so that as S_{Y,X_j} is approaching closer to 0.7, it is closer to insignificance. When the similarity measure is below 0.7, the explanatory variable is insignificant. The gradual transition from being fully significant to being fully insignificant brings additional stability to modeling process while utilizing SR. The binary decision requirement of the MVR method often forces user into dilemma - what to do with respect to a variable when sig>0.05, or other standard cut-off point of significance by a minor degree.

2. **Combined Similarity of all variables to the dependent variable**: Denoted $S^{Comb}_{Y,X_1,...,X_n}$ and ranges between 0 and 1.

Once similarity measures are computed for all the explanatory variables, the next step is to calculate collective contribution of all the explanatory variables combined in explaining the behavior of dependent variable. This measure is denoted $S^{Comb}_{Y,X_1,...,X_n}$ (Yosef et. al, 2015). It reflects, to what degree all the combined explanatory variables explain the behavior of the dependent variable, which is equivalent to R^2 adjusted, used in conventional regression methods. One important difference between the two measurement methods is that by using $S^{Comb}_{Y,X_1,...,X_n}$ we allow for overlap of explanatory variables in their relations with the dependent variable(which is of course more reasonable and more in line with the “real world” behavior), and therefore explanatory variables are not required to be independent of each other.

3. **Relative Importance of explanatory variables**: Denoted *RELIMP*

The way to compute relative importance of the explanatory variables is to find out how much each of them contributes to the $S^{Comb}_{Y,X_1,...,X_n}$. Relative importance of a given explanatory variable(in contrast to traditional regression methods) is not affected by correlation with other explanatory variables, and is determined solely by the contribution of a given explanatory variable to explaining the behavior of the dependent variable.

There are three different options to compute relative importance of explanatory variables:

a. **Regular linear method:** Relative importance of each explanatory variable reflects (directly and proportionally) the contribution of each explanatory variable to the ability of the model to explain behavior of the dependent variable.

b. **Non-linear method:** The main objective of this method is to magnify extremes: To magnify weight of the most important variables, while also accelerating decay of the least important (partially significant) variables towards zero.
c. **Integrated method:** This is an intermediate method where we do not magnify the most important variables, but we do accelerate the decay of partially significant variables.

It is, of course, up to the user to decide which one of the three methods to use. In addition, decision makers can utilize all three methods while performing sensitivity tests for their policy impact simulations. In this study we decided to utilize the first regular linear method.

II. RESULTS

The Summary Table below summarizes all the results of the Soft regression runs.

1. Based on the columns of similarities (S_{Y,X_j}),one can see that only one explanatory variable is insignificant (less than 0.70) namely, Primary Education. The variable Urban Population, which represents the degree of urbanization, expressed as percentage of urban population vs total population of that country, is only partially significant, but is very close to being insignificant**.**

The two other variables - Life Expectancy and Adolescent Fertility, are also partially significant (similarity levels between 0.70 and 0.80), but are very close to the borderline of being fully significant variables.

The additional four variables that are fully significant (similarity higher than 0.80) include: Value of economic activity per capita (GDP/Cap, GNI/Cap), Secondary Education, Tertiary Education and Lagged Fertility Rate.

One can also see that GDP/Cap and GNI/Cap generate very similar results. This outcome is encouraging because it means that it does not matter which measure of the standard of living we select, the results come out similar. We can also notice the similarity between the results generated for 1985 vs. year 2000. This is an indicator of the stability and reliability of the model.

Summary Table:

		S_{Y,X_j}		*RELIMP*		$S^{Comb}_{Y,X_1,\dots,X_m}$	
		1985	2000	1985	2000	1985	2000
	GDP/Cap	0.852^{I}	0.825^{I}	0.178	0.141		
	Secondary	0.858^{I}	0.856^{I}	0.177	0.175		
	Education	0.810^{I}	0.820^{I}	0.119	0.150		
	Tertiary Education	0.929^{D}	0.903^{D}	0.245	0.263	0.976	0.963
	Lagged Fertility	0.781^{D}	0.788^{D}	0.102	0.112		
	Rate	0.798^{I}	0.773^{I}	0.118	0.099		
Natural	Adolescent Fertility	0.736^{I}	0.729^{I}	0.058	0.060		
Population	Life Expectancy	0.624^{I}	0.642^{I}	------	------		
Growth	Urban Population						
	Primary Education						
	GNI/Cap	0.857^{I}	0.824^{I}	0.183	0.146		
	Secondary	0.858^{I}	0.856^{I}	0.177	0.185		
	Education	0.810^{I}	0.820^{I}	0.118	0.158		
	Tertiary Education	0.929^{D}	0.903^{D}	0.245	0.224	0.977	0.963
	Lagged Fertility	0.781^{D}	0.788^{D}	0.101	0.118		
	Rate	0.798^{I}	0.773^{I}	0.118	0.104		
	Adolescent Fertility	0.736^{I}	0.729^{I}	0.058	0.064		
	Life Expectancy	0.624^{I}	0.642^{I}	------	------		
	Urban Population						
	Primary Education						

I-Inverse; D-Direct;

2. Based on the two next columns representing Relative Importance of the various variables (RELIMP), one can see that:

a. There is no weight assigned for the variable Primary Education since we found this variable to be insignificant.
b. The results point to the Lagged Fertility Rate as the most important explanatory variable, thus supporting the conclusions of Soubbotina and Sheram (2000) regarding the "Demographic Momentum". This is not very encouraging result and points to a difficulties involved in effectively carrying out policy to quickly reduce rapid natural population growth, because this is not a policy variable. It represents a status of fertility rate which occurred 20 years ago and obviously no present or future government actions can affect it. Hence,

natural population growth is a stable phenomenon, strongly influenced by past behavior, and only drastic and even draconian measures like in China, can force quick changes in natural population growth in spite of this variable. Otherwise, the changes are expected to be gradual and long term.

c. Next after the "Lagged Fertility Rate", the most important variables are Secondary Education and the Value of Economic Activity per capita (GDP/Cap, GNI/Cap).The variable representing Value of Economic Activity per capita, reflecting average standard of living, is not a simple policy variable. Overwhelming majority of countries desire to find any possible way to rise their standard of living, and vast majority of underdeveloped economies are not successful in these efforts. In fact, in this case we have a vicious cycle: high natural population growth negatively affects the ability of the underdeveloped economies to raise their standard of living over long term periods (see above),which in turn negatively affects the possibility to reduce the rapid population growth.
   However, based on Shnaider and Haruvy (2008), natural population growth is only one of several factors affecting successful economic performance. One of the other variables affecting long term economic performance is Tertiary Education, which is also a significant variable affecting natural population growth in the present model. Hence, Tertiary Education variable affects natural population growth in two ways: It affects natural population growth directly and also indirectly by influencing economic performance.
d. The goal of reaching high tertiary education enrollment levels in underdeveloped countries is not feasible, since in most of these countries the Secondary Education enrollment is still way behind that of the developed world. Hence, the analysis above leaves Secondary Education as the <u>most effective policy variable</u> for underdeveloped countries to lower rapid natural growth of their population. The reasons include:
   1. The variable of Secondary Education has more or less the same weight as the Value of Economic Activity variable, but is much easier to implement successfully.
   2. Based Shnaider and Haruvy (2008) it also affects to some extend the Value of Economic Activity,(although to a much lesser degree in comparison to Tertiary Education), and thus it affects natural population growth also indirectly.
   3. Secondary Education is a prerequisite to achieving Tertiary Education, which significantly affects natural population growth directly and indirectly by significantly affecting Value of Economic Activity" (GDP and GNI per capita).
   4. Of course, in the case of underdeveloped countries, where primary education enrollment is still very low, the policy goal of increasing secondary education enrollment rate could be implemented only partially and raising <u>Primary Education</u> enrollment must become the highest priority policy.
e. Other variables included in this study came out as only partially significant. Even though Life Expectancy and Adolescent fertility are fairly close to being fully significant variables, nevertheless as policy variables they are expected to have much lower influence on natural population growth. In addition, it is expected that the investment in human capital by education, could also positively affect these two variables, and hence have additional indirect positive influence on reducing natural population growth.
f. The variable Urban Population, which refers to the percentage of urban population out of total population, is only partially significant, and very close to the borderline of insignificance. Our model assigned very low relative importance to this variable, and therefore it definitely should not be addressed for policy purposes.

3. The last two columns of the Summary Table indicate to what extend all the explanatory variables combined explain the behavior of the dependent variable ($S^{Comb}_{Y,X_1,\ldots,X_m}$). We can see, that all the results are above 0.96, which is an important indicator of a successful model.

III. SUMMARY AND CONCLUSIONS

In this study we presented quantitative model of natural population growth based on the data of the World Bank from years 1985 and 2000. We included all the variables mentioned in demographic literature that were available to us. We utilized Soft Regression as a modeling technology. Soft regression is in particular a very reliable modeling tool to evaluate the relative importance of the variables, which is of crucial importance when determining policy priorities. The model pointed out to Lagged Fertility as the most important variable, thus validating the importance of "Demographic Momentum". Hence, the implication is that natural population growth is greatly influenced by long term trends and cannot be easily diverted to a more moderates lower pace. In other words, the outcome of demographic policies is expected to be slow, and will take years even when utilizing reasonable demographic policies. Obviously, Lagged Fertility variable is not a policy variable, since no government policy can change what actually have already happened.

Another important factor is a Value of Economic Activity per capita, which in our model is represented by two separate variables, GDP per capita and GNI per capita. This is also not a policy tool, since increasing value of economic activity per capita (representing standard of living)is a major policy goal for governments, and the reduction in natural population growth is, in fact, designed to contribute to reaching this goal.

Education seems the most important policy tool. Our model points to Secondary Education enrollment as the most important education variable directly related to the natural population growth. In addition, according to Shnaider and Haruvy (2008), secondary education enrollment also influence the value of economic activity per capita, and through that variable affects natural population growth indirectly (to a minor degree).

Another important policy variable is a tertiary education enrollment. It is a significant variable. Its relative importance is lesser in comparison to the secondary education enrollment (as far as a direct impact on a natural population growth), however, according to Shnaider and Haruvy (2008), it is an important variable affecting the value of economic activity per capita, and hence also affects indirectly natural population growth..

The education variable of Primary Education enrollment is found to be insignificant. However, no widespread secondary education enrollment is possible without first achieving widespread primary education. The fact that the primary education enrollment is insignificant basically means that vast majority of underdeveloped countries have already achieved primary education enrollment level close enough to the level of developed economies. However, for the underdeveloped countries characterized by a low primary education enrollment, obviously Primary Education becomes the highest priority policy variable.

Two additional variables tested in our model are Life Expectancy and Adolescent Fertility Rate. Both variables came out partially significant, but fairly close to being fully significant. Nevertheless, they are definitely lower priority variables in comparison to the education variables. In addition, education variables are expected to influence in the long run both, life expectancy and adolescent fertility, and hence influence indirectly natural population growth through these variables.

Urban Population variable calculated as the percentage of urban population of the total population, came out partially significant variable and very close to being insignificant, so it should not be considered for the relevant policy purposes.

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