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Did Infant Mortality Decline cause Fertility Decline? Evidence from a Panel Data Analysis of Developing Countries.

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Abstract

The nexus between infant mortality decline and fertility decline has been the subject matter of several theoretical and empirical investigations. However, this relationship still remains an open question, as the literature provides only mixed empirical evidence. We investigate this relationship by using a panel data of 47 developing countries from 1960-2012. Using system generalized method of moments (GMM) estimation, which allows us to control for potential endogeneity of infant mortality in fertility regression, we conclude that the decrease in infant mortality did not result in the observed fertility decline (a positive association); on the contrary, we observe a negative relationship to exist between the two. This result casts some doubt on Barro-Becker (1989) assertion that altruistic parents favored children's quality over quantity in the presence of declining infant mortality, which led to fertility decline.

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1. Introduction

The primary objective of this paper is to reexamine the relationship between infant mortality and fertility. Demographers have noticed that the fertility decline is preceded by the mortality decline; which insinuates that there is a causal link running from mortality decline to fertility decline (Doepke, 2005). This demographic transition has been studied by many economists including Barro and Becker (1989), who postulate, as pointed out by Doepke (2005), that the child and infant mortality rate decline decreases the cost of raising surviving children, and therefore, fertility rate should increase, but it does not increase, because altruistic parents faced with quantity-quality tradeoff, end up incurring the higher cost associated with human capital acquisition of their children; thereby, restricting the number of children, and sacrificing the relatively cheaper option of having a large number of offspring, which has its own benefits for them, such as greater likelihood of receiving old age support from surviving children and more helping hands in the household enterprise, among others.

We, in this paper, try to infer whether it is quantity or quality that prevailed by looking at the estimates from a panel data of developing countries. A positive sign of the coefficient of infant mortality in the fertility regression can be construed to be providing evidence in favor of quantity. Whereas, a negative sign would imply quality.

The above assertion can be better understood by supposing that the parents are of two types: (1) those who prefer the quality of surviving offspring irrespective of the number, and (2) those who prefer the quantity. The latter group prefers a pre-specified desired number of surviving children for the reasons mentioned above. Both groups of parents face the budget constraint. If infant and child mortality increases, then the probability of a child surviving decreases, and while facing this scenario, the first group of parents would choose to have smaller number of children, as the marginal benefit of an additional child is outweighed by the marginal cost (includes psychic cost as well) of that child. Whereas, the second group of parents, in accordance with their preference, would try to increase the probability of having a desired number of children by reproducing more children, and hope that a certain number of them would survive. Clearly, for this group of parents marginal benefit exceeds marginal cost, till the desired number of surviving children is attained. So, if the sign of the coefficient of infant mortality rate is positive, then it would not be preposterous to suggest that the group comprising quantity favoring parents is in greater proportion than the group comprising quality favoring parents, and if the sign is negative, then the quality favoring parents dominate the quantity favoring parents. Similar conclusions can be drawn, if infant and child mortality decreases, as observed in the data, then the second group of parents may not try to have as many children, because the odds of survival have increased, and they can have the desired number of children without procreating too many offspring. Whereas, the first group will respond to lower infant mortality by having more children, since marginal benefit now exceeds the marginal cost of an additional child. So, once again, if the sign is positive, then it would suggest that the quantity preferring parents dominate quality preferring parents, and if the sign is negative then the opposite is likely to be true.

2. Background Literature

The existing literature attributes the decline in fertility rate to many factors in addition to infant and child mortality. A brief description is provided below of some of the important literature. This also helps us in choosing the set of controls to be used in our fertility regression.

Becker (1981) postulates that parents reduce fertility because of higher wages which raises the opportunity cost of raising children. According to Caldwell (1976), modernization and development has decreased the need for old age support from children resulting in a decline in fertility. Galor & Weil (1999, 2000) claim that the technological change results in higher returns to education, which forces the parents to face the quantity-quality tradeoff, which in turn results in the observed demographic transition. Galor & Weil (1996) in another paper argue that higher wages for women raise the opportunity cost of raising children more than the household income, and therefore parents decrease fertility in response. Becker & Barrow (1998) attribute fertility decline to an increase in the aggregate consumption. Becker et.al (1990) attribute fertility decline to an augmentation in the aggregate human capital. Azariadis & Drazen (1991) attribute the fertility decline to structural changes taking place in the economy. The role of family planning especially in the context of developing countries has also been studied, but has not been found to be a significant contributor to the fertility decline (see for example, Weil, 2001). Doepke (2005) from his theoretical analysis concludes that the decline in child and infant mortality rates is not the reason for the observed decline in the net fertility rate.

Empirically, Eckstein et.al. (1998), Galloway et.al. (1998), Coale (1986), and Preston (1978) find that decrease in child and infant mortality is associated with fertility decline. Van de Walle (1986) using the European historical data also finds that infant mortality and fertility are positively related, however, she does not claim that the decline in infant mortality is the reason for decline in mortality rate. Ozcan (2003) suggests that in spite of previous studies on this topic, the empirical validation remains an open question.

In this paper, we conduct an empirical test to verify the nexus between infant mortality and fertility using a panel data of 47 developing countries from 1960-2012. The main contribution of this paper is the use of dynamic panel specific system GMM estimator that allows us to control for potential endogeneity of infant mortality in fertility regression. Previous studies have failed to control for this bias, and therefore, their conclusions cannot be relied upon with a greater degree of confidence.

3. Methodology

We estimate the following equation:

$$y_{i,t} = \beta_0 + \beta_1 IMR_{i,t} + \beta_j X_{i,t} + \varepsilon_{i,t} \quad (1)$$

where y_{it} is the fertility rate in country *i* in time period *t*. The term IMR_{it} is the variable of interest and denotes the infant mortality rate in country *i* in time period *t*. The term X_{it} is a matrix of other controls for fertility rate - percentage of the population living in an urban area (urbanization rate), GDP per capita in US dollars, life expectancy at birth (in number of years, serves as one of the proxies for health measures), agriculture value added (percentage of GDP, serves as one of the proxies for dependence on agriculture), net official development assistance received (current US dollars), DPT immunization (percentage of children ages 12-23 months, serves as a proxy for health measures), electricity consumption (kwh per capita, serves as a proxy for industrialization), agricultural land (percentage of land, serves as a proxy for dependence on agriculture), ratio of girls to boys in secondary education (proxy for gender equality), contraceptives use, percentage of population age less than 14 years, percentage of population in the 15-64 years range (the last two being demographic controls), country time trends, and quadratic time trends. The term ε_{it} is the idiosyncratic error term, which consists of time invariant as well as time varying components. Our primary interest is in estimating the coefficient β_1. The pooled OLS estimates might be biased due to the potential endogeneity of infant mortality rate in the above equation. In other words, the unobserved error term might be correlated with IMR. One solution is to resort to the fixed effects estimator that differences out the time invariant component of the error term and removes the bias due to that component. However, it is still possible that the time variant component of the error term in this equation continues to bias the estimate. Another option is to find an instrumental variable that is correlated with IMR, but is not correlated with the unobserved error term. In practice, however, for a cross-country regression such an instrument is hard to find. To address this endogeneity problem, we resort to the dynamic panel specific system GMM estimator developed by Arellano-Bond (1991), which was originally proposed by Holtz-Eakin et.al. (1988). This estimator has been used in many settings and have been employed with increasing frequency to address the endogeniety bias in various panel settings (see for example, Dutt, 2009; Cardenas & Sharma, 2011; Fadi *et.al*. 2014). The dynamic panel equation that we estimate is given by the following:

$$y_{i,t} = \beta_0 y_{i,t-1} + \beta_1 IMR_{i,t} + \beta_j X_{i,t} + \varepsilon_{i,t} \qquad (2)$$

where $y_{i,t-1}$ is the one period lagged value of the dependent variable $y_{i,t}$.

We use the augmented version of system GMM because sometimes the lagged levels of the explanatory variables are poor instruments for the first-differenced explanatory variables. The system GMM estimator uses the levels equation to obtain a system of two equations: one differenced and one in levels. By adding the second equation additional instruments can be obtained. Thus, the variables in levels in the second equation are instrumented with their own first differences. This usually increases efficiency (see for example, Mileva, 2007). Also, to ensure that the results are not driven by the number of instruments, which can be large if all lags are used up and influences the estimates, we rely only on one particular lag of the exogenous variables as proposed by Roodman (2009).[1]

It is well understood that for the system GMM estimator to be consistent two conditions must be fulfilled. First, the idiosyncratic error term should not be serially correlated and second, the instrumental variables created from the lagged values of the explanatory variables must be valid. Arellano-Bond recommended the inspection of serial correlation in the error term. This test attempts to detect the first- and second-order serial correlation in the differenced error term (the residuals from the regression in differences). It is not uncommon for the differenced error term to display first order serial correlation, even if the residuals in levels are uncorrelated. However, the presence of second-order serial correlation indicates that the moment conditions are invalid resulting in inconsistent estimates. The second specification test is the Hansen test of exogeneity of instruments, which tests the null hypothesis of overall validity of the instruments. Failure to reject this null hypothesis lends support to the validity of instruments (see for example, Mileva, 2007; Cardenas & Sharma, 2011; Dutt, 2009). We report the results of these two tests at the bottom of table 1.

4. Data

The data used in this analysis is obtained from the World Bank. We include forty-seven countries in this study, and all forty-seven were in various stages of their development process at the starting year of 1960. These countries are from the following areas: Latin America, Northern Africa, Sub-

[1] This is due to an anonymous referee.

Saharan Africa, Middle East, Eastern Asia, Southeast Asia, East Asia, and Eastern Europe (refer to appendix for complete list). The analysis covers the time period from 1960 to 2012, as this allows us to obtain the data for most of the important explanatory variables. The resulting data set is an unbalanced panel.

Next, we present the results from the pooled OLS, Fixed Effects, Random Effects, and System GMM estimations in table 1.

Table 1: Regression Results of Fertility Rate, Full Sample (1960-2012)

Variable	Pooled OLS	Fixed Effects	Random Effects	System GMM
Lag Fertility				1.047***
				(.053)
Urbanization	-.000	-.001	-.004	-.003*
	(.001)	(.012)	(.006)	(.001)
GDP per capita	.000	.000	.000*	-1.06e-
	(.000)	(.000)	(.000)	(9.20e-)
Life expectancy	-.000	.009	.006	-.008**
	(.004)	(.014)	(.014)	(.003)
Infant Mortality Rate	.004**	.005	.006	-.002**
	(.002)	(.006)	(.006)	(.001)
Agriculture value added	.000	-.007	-.004	-.000
	(.003)	(.008)	(.008)	(.000)
Net ODA received	-6.13e-***	-7.21e-**	-8.57e- ***	dropped
	(2.06e-)	(2.75e-)	(2.70e-)	
Ratio of Girls to Boys in	-.002	-.008**	-.006	-.000
secondary education	(.001)	(.004)	(.004)	(.000)
DPT Immunization	-.001	-.004	-.003	.000
	(.001)	(.002)	(.002)	(.000)
Electricity Consumption	-.000	-.000	-.000	-2.28e-
	(.000)	(.000)	(.000)	(5.96e-)
Agricultural Land	-.005***	.008	-.005	.000
	(.000)	(.009)	(.004)	(.000)
Contraceptives prevalence	-.023***	-.031***	-.037***	-.000
	(.001)	(.009)	(.007)	(.001)
Labor Force Participation	.000	-.002	-.002	.000
rate	(.001)	(.005)	(.003)	(.000)
Population ages 0-14	.018*	-.277***	-.135**	-.010
	(.010)	(.074)	(.055)	(.015)
Population ages 15-64	-.114***	-.340***	-.222***	.010
	(.014)	(.085)	(.061)	(.022)
Time trend	-.075***	-.103**	-.074*	.007
	(.026)	(.041)	(.040)	(.013)
Time trend square	.0009***	.000	.000	-.000
	(.0003)	(.000)	(.000)	(.000)

Intercept	12.773***	37.891 ***	25.562***	
	(1.434)	(8.685)	(6.981)	
Number of Observations	653	653	653	489
R-Square	0.929	0.89(within)	0.88(within)	

*** denotes significance at 1%, ** denotes significance at 5%, * denotes significance at 10%.
First entry in each cell is the coefficient. Clustered Robust standard errors are provided in the parentheses.
The following is for the system GMM:
Arellano-Bond test for AR(1) in first differences: z = 0.65, Pr > z = 0.519; Arellano-Bond test for AR(2) in first differences z = -0.29, Pr > z = 0.770; Difference-in-Hansen tests of exogeneity of instrument subsets:

(GDP Per Capita GDP Agr Net Official DevAss Electric Power Consumption Agricultural Land Urban Pop Life Expectancy at birth total Immunization DPT Ratio Girls to Boys Sec Edu contraceptive prevalence labor force participation rate population ages 014 population ages 15-64 time t^2); Hansen test excluding group: chi2(30) = 22.37 Prob > chi2 = 0.840

5. Discussion

The results based on pooled OLS, fixed, and random effects estimators suggest that a decrease in infant mortality rate decreases the fertility rate and the coefficient is statistically significant at the 5% level in the case of pooled OLS and is not statistically significant in the latter two cases. However, the effect of IMR is negative and statistically significant at the 5% level when we resort to the system GMM estimator, which allows us to effectively control for the potential endogeneity bias. This implies that a decrease in infant mortality rate increases the fertility rate. Here we have used only the first lag of the exogenous variables as instrument to control for endogeneity bias as suggested by Roodman (2009). This conclusion remains valid when we use either the second or the third lag to generate instrument (These results will be provided upon request). The finding of this paper clearly suggests that the declining infant mortality rate is not the cause of fertility rate decline. Previous studies that claimed on the contrary did so without controlling for potential endogeneity of IMR in the fertility regression.

Next, we outline the results from the system GMM estimation for the other controls. The lag fertility rate is positively associated with the fertility rate and is highly significant at the 1% level. An increase in urbanization rate is negatively associated with fertility rate, and is statistically significant. An increase in life expectancy at birth has a negative and statistically significant effect on fertility rate. The other controls have no statistically significant effect on fertility rate. Interestingly, even though contraceptives use, demographic controls, and country specific linear time trends are statistically significant in pooled OLS, fixed, and random effects estimations, they are not in the system GMM estimations.

6. Conclusion

The relationship between infant mortality and fertility has been the subject of many studies in demography, sociology, and economics. In spite of this copious amount of work, we are still far from a definitive answer to this connection between the two. Most of the previous empirical work suffers from potential endogeneity of infant mortality in the fertility regression, and therefore, the estimates should be viewed with suspicion, as they are biased. This paper attempts to address this gap in the literature by relying on a dynamic panel data specific system GMM estimator, which enables one to control for the endogeneity of infant mortality. Based on this estimation, we conclude, in a causal sense, that the infant mortality rate decline did not cause the fertility rate decline when the other factors are also controlled for. What we find however is the existence of a negative relationship between the two variables. This negative relationship can be justified in terms of Barro-Becker (1989) postulated quantity-quality tradeoff faced by the parents due to a decline in infant and child mortality rates. In the light of the result of this paper, one can think that a greater proportion of parents chose quantity over quality, possibly due to a higher precautionary demand for children, or greater demand for child labor in the household enterprise, or greater reliance on children for old age support, or something else. However, to know the exact reason one will have to design a careful study that teases out the causal explanations behind the observed demographic transition.

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Appendix:

Countries by region:

Latin America – Benin, Brazil, Bolivia, Argentina, Chile, Columbia, Costa Rica, Cuba, Ecuador, Honduras, Mexico, Panama, and Peru

North Africa – Morocco, Algeria, Egypt, and Sudan

Sub-Saharan Africa – Botswana, Corte d'Ivoire, Cameroon, Republic of Congo, Ethiopia, Ghana, Kenya, Rwanda, Sudan, Senegal, Togo, Zambia, and Zimbabwe

Middle East – Bahrain, Iran, Jordan, Kuwait, Oman, and Turkey

South Asia – India, Pakistan, Bangladesh, Sri Lanka, and Nepal

Southeast Asia – Indonesia, Malaysia, Philippines, and Thailand

East Asia – China, Korea

Eastern Europe – Bulgaria