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POPULATION

ODED GALOR

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Fertility and Growth

Oded Galor

Brown University

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Abstract

This paper explores the theoretical foundations and the testable implications of the various mechanisms that have been proposed as possible triggers for the demographic transition. Moreover, it examines the empirical validity of each of the theories and their significance for the understanding of the transition from stagnation to growth, and it provides estimates for the effect of fertility decline on economic growth.

Department of Economics, Brown University, Providence, RI 02912 (email: Oded_Galor@brown.edu).

Introduction

The demographic transition has swept the world since the end of the nineteenth century. The unprecedented increase in population growth during the Post-Malthusian Regime has been ultimately reversed, bringing about significant reductions in fertility rates and population growth in various regions of the world.

The demographic transition has enabled economies to convert a larger portion of the gains from factor accumulation and technological progress into growth of income per capita. It enhanced labor productivity and the growth process via three channels. First, the decline in population growth reduced the dilution of the growing stocks of capital and infrastructure, increasing the amount of resources per capita. Second, the reduction in fertility rates permitted the reallocation of resources from the quantity of children toward their quality, enhancing human capital formation and labor productivity. Third, the decline in fertility rates affected the age distribution of the population, temporarily increasing the fraction of the labor force in the population and thus mechanically increasing productivity per capita.

This paper examines various mechanisms that have been proposed as possible triggers for the demographic transition and assesses their empirical significance in understanding the transition from stagnation to growth. Was the onset of the fertility decline an outcome of the rise in income during the course of industrialization? Was it triggered by the reduction in mortality rates? Was it fueled by the rise in the relative wages of women? Or was it an outcome of the rise in the demand for human capital in the second phase of industrialization? In addition, the paper provides some estimates for the effect of the decline in fertility on economic growth.

The Rise in the Level of Income Per Capita

The rise in income per capita prior to the decline in fertility has led some researchers to argue that the reduction in fertility was triggered by the rise in income in the process of industrialization. In particular, Becker (1960) advanced the argument that the decline in fertility was a by-product of the rise in income and the associated rise in the opportunity cost of raising children. His thesis suggests that the rise in income induced a fertility decline because the positive income effect on fertility was dominated by a negative substitution effect brought about by the rising opportunity cost of raising children. Similarly, Becker and Lewis (1973) postulated that the income elasticity with respect to investment in children's education was greater than that with respect to the number of children, and hence the rise in income led to a decline in fertility along with an increase in the investment in each child.

However, this preference-based theory is fragile from a theoretical viewpoint. It hinges on the supposition that individuals' preferences reflect an innate bias against child quantity beyond a certain level of income. Most critically, it generates testable predictions that appear inconsistent with the evidence.

The theory appears counterfactual on both counts. The decline in fertility occurred in the same decade across Western European countries that differed significantly in their income per capita. The simultaneity of of the demographic transition across Western European countries that differed significantly in their incomes per capita suggests that the high levels of income reached by these countries in the Post-Malthusian Regime played a very limited role, if any, in the onset of the demographic transition, refuting the first testable implication of the Beckerian theory.

Moreover, the evidence presented by Murtin (2009) (based on a panel of countries during 1870–2000) shows that income per worker was positively associated with fertility rates, once controls were introduced for mortality rates and education. Recent empirical examinations of the various factors that contributed to the demographic transition within an economy also refute the second implication of the Beckerian theory. In particular, cross-sectional evidence from France and England does not lend support to the theory. Murphy (2009) finds, based on panel data from France during 1876–1896, that income per capita had a positive effect on fertility rates during France's demographic transition, accounting for education, the gender literacy gap, and mortality rates.

The Decline in Infant and Child Mortality

The decline in infant and child mortality that preceded the reduction in fertility and population growth in most advanced economies, with the notable exceptions of France and the United States, has been viewed as a plausible explanation for the onset of the decline in population growth during the demographic transition. Nevertheless, this hypothesis appears to be non-robust theoretically and inconsistent with historical evidence.

The theory suggests that mortality rates have a positive effect on total fertility rates. Declines in mortality would not lead to a reduction in the number of surviving offspring unless the number of surviving children is uncertain and the following conditions are satisfied: (i) there exists a precautionary demand for children (i.e., individuals are risk averse with respect to the number of surviving offspring and thus hold a buffer stock of children in a high-mortality environment); (ii) risk aversion with respect to consumption is not larger than risk aversion with respect to the number of surviving children; (iii) sequential fertility (i.e., replacement of non-surviving children) is modest; (iv) parental resources saved from the reduction in the number of children that do not survive to adulthood are not channeled toward childbearing.

While it is plausible that mortality rates were one of the factors that affected the level of fertility throughout human history, historical evidence does not lend credence to the argument that the decline in mortality accounts for the reversal of the positive historical trend between income and fertility and for the decline in population growth (i.e., fertility net of mortality).

The decline in mortality in Western Europe started nearly a century prior to the decline in fertility and was associated initially with increasing fertility rates in some countries. In particular, the decline in mortality started in England in the 1730s and was accompanied by a steady increase in fertility rates until 1800. The sharp decline in fertility in the course of the demographic transition occurred during a period in which income per capita maintained its earlier positive trend, while mortality declines maintained the course that had existed in the 140 years preceding the decline in fertility. The sharp reversal in the fertility patterns in Western European countries in the 1870s, in the context of this stable pattern of mortality decline, therefore, suggests that the demographic transition was prompted by a different universal force.

Recent quantitative and empirical evidence supports the viewpoint that a decline in infant mortality rates was not the trigger for the decline in net fertility during the demographic transition. Doepke (2005), using the mortality and fertility data from England during 1861–1951, finds that in the absence of changes in other factors, the decline in child mortality during this time should have resulted in a rise in net fertility

rates, in contrast to the evidence. A similar conclusion about the insignificance of declining mortality for determining the decline in fertility during the demographic transition is reached in the quantitative analysis of Fernández-Villaverde (2001). Moreover, Murphy (2009) suggests, based on panel data from France during 1876–1896, that the mortality rate had no effect on fertility during France's demographic transition, accounting for education, income, and the gender literacy gap.

Importantly, it is the reduction in net fertility and thus in population growth that is most relevant from the viewpoint of the theory of economic growth. However, in light of the implausible set of conditions that must be met for a decline in mortality rates to generate a decline in net fertility, the observed sharp decline in the number of surviving offspring (i.e., net reproduction rate) during the demographic transition raises further doubts about the significance of mortality declines in triggering the onset of the decline in population growth.

The Rise in the Demand for Human Capital

The gradual rise in demand for human capital during the second phase of industrialization and its close association with the timing of the demographic transition has led researchers to argue that the increasing role of human capital in the production process induced households to increase their investment in the human capital of their offspring, leading to the onset of the fertility decline.

Galor and Weil (2011) argue that the acceleration in the rate of technological progress during the second phase of the Industrial Revolution increased the demand for human capital and induced parents to invest more heavily in the human capital of their offspring. This increase in the rate of technological progress and the associated increase in parental income and demand for human capital brought about two effects on population growth. On the one hand, the rise in income eased households' budget constraints and provided more resources for quality as well as quantity of children. On the other hand, it induced a reallocation of these increased resources toward child quality. In the course of transition from the Malthusian Epoch, the effect of technological progress on parental income dominated, and population growth as well as the average population quality increased. Ultimately, further increases in the rate of technological progress induced a reduction in fertility, generating a decline in population growth and an increase in the average level of education.

Suppose that individuals generate utility from the quantity and the quality of their children as well as from their own consumption. They choose the number of children and their quality in the face of a constraint on the total amount of time that can be devoted to child-raising and labor-market activities. A rise in parental income due to a rise in the demand for parental human capital would generate, in contrast to Becker and Lewis (1973), conflicting income and substitution effects that would not necessarily trigger a decline in fertility. However, the rise in the future demand for the children's human capital would lead to a pure substitution effect, which would induce parents to substitute quality for quantity of children.

Consistent with the theory, the growth rates of income per capita among Western European countries were were rather similar during their demographic transition, despite large differences in their levels of income per capita. The average growth rate among northwestern European countries during this period was 1.3% per year – ranging from 1.0% per year in the United Kingdom, 1.3% in Norway, 1.4% in Finland and

France, 1.5% in Sweden, to 1.6% in Germany (Maddison, 2001). Moreover, the adverse effect of an increase in productivity in the advanced stages of development on net fertility has been established by Lehr (2009) using a pooled cross-sectional time series sample during 1960–1999.

Furthermore, evidence from a panel of countries during 1870–2000 demonstrates that investment in education was indeed a dominating force in the decline in fertility. In particular, educational attainment has been negatively associated with fertility, accounting for income per worker and mortality rates (Murtin, 2009). Importantly, cross-sectional evidence from France, Germany, and England supports the hypothesis that the rise in human capital formation has had an adverse effect on fertility. Becker et al. (2010) find that education stimulated a decline in fertility in Prussia during the nineteenth century. Similarly, Murphy (2009) finds, based on panel data from France during 1876–1896, that the level of education attainment had an adverse effect on fertility rates during France's demographic transition, accounting for income per capita, the gender literacy gap, and mortality rates.

The decline in fertility in England was associated with a significant increase in the in- vestment in child quality as reflected by years of schooling. In particular, Klemp and Weisdorf (2010) establish a causal effect of family sibship size on individual literacy using demographic data for 26 English parishes during 1580–1871. Exploiting exogenous variation in sibship size, stemming from parental fecundity, they find that each additional sibling reduces literacy among all family siblings.

A direct test of the effect on fertility of the rise in the return on human capital has been conducted by Bleakley and Lange (2009) in the context of the eradication of hookworm disease in the American South (circa 1910). Noting that the eradication of this disease can be viewed as a positive shock to the return to child quality since (i) it raises the return on human capital investment, (ii) it had a very low fatality rate, and (iii) it had negligible prevalence among adults, they find that the rise in the return to child quality had a significant adverse effect on fertility rates.

Finally, the prediction of the theory regarding the adverse effect of increased preference for educated offspring on fertility rates is also supported by the empirical evidence (Becker et al., 2010).

The Decline in the Gender Gap

The rise in demand for human capital and its impact on the decline in the gender wage gap during the nineteenth and the twentieth centuries have contributed to the onset of the demographic transition. In particular, the rise in women's relative wages during the process of development, its positive impact on female labor force participation, and its adverse effect on fertility rates have been at the center of a complementary theory of the demographic transition that generates the observed hump-shaped relationship between income per capita and population growth.

A pattern of rising relative wages for women and declining fertility rates has been observed in a large number of developed and less developed economies. In addition, the process of development has been associated with a gradual decline in the gender gap in human capital formation. As depicted in Figure 4.5, the literacy rate among women in England, which was only 76% of that of men in 1840, grew rapidly during the nineteenth century and reached the male level in 1900.

The role that the decline in the gender wage gap played in the onset of the demographic transition has been examined by Galor and Weil (1996). They argue that technological progress and capital accumulation in the process of industrialization increased the relative wages of women and triggered the onset of the demographic transition. They maintain that technological progress, along with physical capital accumulation, complemented mentally-intensive tasks more than physically-intensive tasks in the production process, raising the return to brain relative to brawn. Thus, in light of the comparative physiological advantage of men in physically intensive tasks and of women in mentally intensive tasks, the demand for women's labor gradually increased in the industrial sector, decreasing the gender wage gap.

In the early stages of industrialization, as long as the rise in women's wages insufficient to induce a significant increase in women's labor force participation, fertility increased due to the income effect generated by the rise in men's wages in the increasingly more productive industrial sector. Ultimately, however, the rise in women's relative wages was sufficient to induce a significant increase in their labor force participation. This process increased the cost of child rearing proportionately more than the increase in household's income, triggering a fertility decline. Moreover, the rise in demand for human capital in the process of development induced a gradual improvement in women's education. It raised the opportunity cost of raising children more than the increase in household income, and reinforced the fertility decline and the rise in female labor force participation. .

Thus, unlike the single-parent model in which an increase in income generates conflicting income and substitution effects that cancel one another if preferences are homothetic, in the two-parent household model, if most of the burden of child rearing is placed on women, a rise in women's relative wages increases the opportunity cost of raising children more than household income, generating a pressure to reduce fertility.

The role of the decline in the gender wage gap in the demographic transition is supported empirically. Schultz (1985) finds that an increase in the relative wages of women played an important role in Sweden's fertility transition, and Murphy (2009) suggests, based on panel data from France during 1876–1896, that a reduction in the gender literacy gap had an adverse effect on fertility during France's demographic transition, accounting for income per capita, educational attainment, and mortality rates.

The Old-Age Security Hypothesis

The old-age security hypothesis has been proposed as an additional mechanism for the onset of the demographic transition. It suggests that in the absence of capital markets which permit intertemporal lending and borrowing, children serve as an asset that permits parents to transfer income to old age. Hence, the establishment of capital markets in the process of development reduced this motivation for rearing children, contributing to the demographic transition.

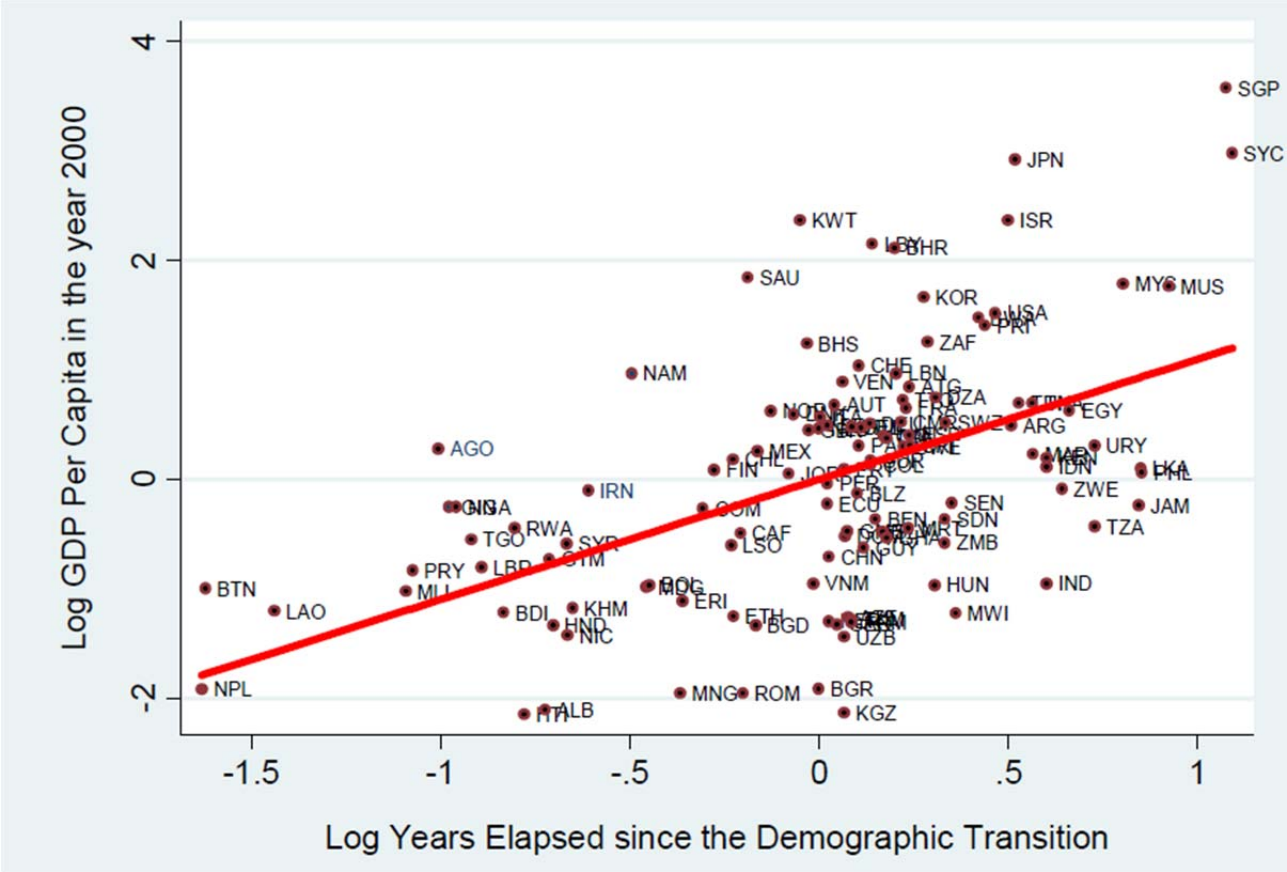
Although old-age support is a plausible element that may affect the level of fertility, it appears as a minor force in the context of the demographic transition. First, since there are only rare examples in nature of offspring that support their parents in old age, it appears that old-age support cannot be the prime motivation for child rearing. Second, institutions supporting individuals in their old age were formed well before the demographic transition.

The rise in fertility rates prior to the demographic transition, in a period of improvements in credit markets, raises further doubts about the significance of this mechanism. Moreover, cross-sectional evidence shows that in the pre-demographic transition era wealthier individuals, who presumably had better access to credit markets, had a larger number of surviving offspring, increasing the skepticism about the importance of this hypothesis. Thus the decline in the importance of old-age support is unlikely to be a major force behind the significant reduction in fertility – at a rate of 30–50% – that occurred during the demographic transition.

The Demographic Transition and the Origins of Modern Growth

Unified Growth Theory (Galor, 2011) suggests that the transition from stagnation to growth is an inevitable by-product of the process of development. It argues that the inherent Malthusian interaction between the rate of technological progress and the size and the composition of the population accelerated the pace of technological progress and ultimately raised the importance of human capital in the rapidly changing technological environment. The rise in the demand for human capital and its impact on human capital formation triggered a reduction in fertility rates and population growth and further technological advances. The demographic transition has enabled economies to divert a larger share of the fruits of factor accumulation and technological progress from fueling population growth toward the enhancement of human capital formation and income per capita, thus paving the way for the emergence of sustained economic growth.

Figure 1. Income Per Capita in 2000 and the Time Elapsed since the Demographic Transition.



Thus, Unified Growth Theory suggests that the demographic transition played an important role in the emergence of modern growth. Indeed, cross-country evidence, depicted in Figure 1, shows that contemporary income per capita are significantly and positively associated with the time elapsed since the demographic transition.

Estimating the Effects of Fertility Decline on Economic Growth

Existing estimates of the effects of fertility decline on economic growth are largely imprecise and speculative, since they are based on assumptions that could not be verified about the elasticity of human capital formation and technological progress with respect to fertility. Historic evidence of countries that went through demographic transition earlier could provide some initial conjectures about the feasible range of these effects in some regions of the world. In particular, the average total fertility rate (TFR) in Sub-Saharan Africa was about 5 in the year 2009. This level corresponds to the TFR of major Western European countries around 1870. From this level, TFR declined to a range of 2 to 2.5 within a 50-year period. During this period, enrollment in primary schools increased significantly, ranging from 6% in Germany to 45% in Finland. In addition, over this period, the growth of Per capita GDP ranged from 60% in countries in the region to 300% in Sweden. Moreover, in Western European countries, to decline in TFR by 1 was accompanied by varying increases in the level of per capita GDP, from 17% in England and Wales to 70% in Norway.

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