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Can sustained economic growth and declining population coexist?☆

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ABSTRACT

Most of the developed countries have been experiencing sub-replacement fertility. This leads to worries over the sustainability of economic growth in these countries. Given this concern, we ask the following questions: Is there a force that would allow economic growth and declining population to coexist? Is there a mechanism that could reverse the decline in fertility? We argue that returns to human capital in production provide the key to understanding this relation. Our theoretical framework predicts that, when the degree of increasing returns to human capital in traditional production technologies falls, advanced economies switch their productive efforts from labor-oriented technologies that require a constant creation of young workforce toward human capital-oriented technologies that support an ageing population. We call this shift the "endogenous efficiency-augmenting mechanism". This suggests that sustained economic growth and a declining population can coexist in the long run. Finally, we compare our model against the data and find: (*i*) The degree of increasing returns to human capital has been falling over time throughout the world along with population growth rates. (*ii*) Increasing returns to human capital and population growth rates are positively correlated. (*iii*) Predictions of our model are consistent with what the data reveal.

1. Introduction

A majority of the developed countries are expected to face declining populations in the foreseeable future if their fertility rates stay below the replacement rates. Japan is the most prominent example. As a result of five consecutive decades of low birth rates and almost no net immigration, its population fell by 0.01% in 2005, followed by zero growth in 2006 and 2007, and a 0.06% decline in 2008. Recent population projections of the Ministry of Internal Affairs and Communications in Japan suggest that Japanese population, which is currently around 127 million, will decline steadily during the first half of the 21st century to reach 95 million—close to its 1960 levels—in 2050. Similar concerns are raised for many European and Asian nations. The US has relatively high fertility, but still way below its historical standards.

Among the most significant issues is the impact of declining population on economic growth. In this paper, we ask the following questions. Is there a force that would allow economic growth and declining population to coexist? Is there a mechanism that could reverse the decline in fertility? The literature on fertility and economic growth argues that, *along the development path*, parents have fewer children each with higher quality. As a result, fertility declines and the stock of human capital grows, which lead to sustained economic growth in per capita terms. This is the main mechanism suggested by many papers including Becker et al. (1990) and Galor and Weil (1999, 2000). It explains what happens at the early stages of development quite well.[1] Our research is motivated by the observation that there is no serious theory linking fertility, human capital accumulation, and economic growth once we get to the modern advanced economy with below replacement fertility. There are serious calls for such a contribution [see Galor (2008) and Murphy (2009)]. Unlike the majority of papers in the fertility and growth literatures, we do *not* attempt to model transition from underdevelopment to development. Our goal is to construct a model of fertility and growth in advanced societies rather than to investigate what happens during the process of development.

This paper argues that the degree of increasing returns to human capital in traditional production technologies determines the nature of the long-term relationship between economic growth and population growth in advanced countries. By traditional technologies, we mean labor-oriented production processes prevalent in traditional manufacturing and services sectors. These sectors have benefited

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[1] See, for example, Galor and Weil (1996), Galor and Moav (2002), Lagerloef (2003), Moav (2005), Azarnert (2006), Gould et al. (2008), Angeles (2010), and Ludwig and Vogel (2010) for different perspectives on the determinants of this demographic transition. See Galor (2005) for an excellent survey.

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largely from increasing returns to human capital generated through agglomeration economies and the formation of cities throughout the second half of the twentieth century [see Moretti (2004a,b)].

Our theoretical structure combines the models developed by Becker and Lewis (1973), Becker and Barro (1988), Becker et al. (1990), and Lucas (1988). Like Becker and Lewis (1973) and Becker et al. (1990), quantity–quality tradeoff at the aggregate level is an important element in our analysis. Unlike these papers, we generate this tradeoff in a novel way: the goods cost of child rearing is an increasing function of the aggregate human capital. This assumption communicates the idea that human capital is a cost element as well as a productivity element for the society; that is, part of the human capital stock is accumulated for the purpose of raising higher quality children. When the population starts declining, this mechanism works in the opposite direction to produce extra resources for the society. We explain this "efficiency-augmenting mechanism" in greater detail in Section 2. Like Becker and Barro (1988) and Becker et al. (1990), our model is based on a dynastic utility structure. Like Becker et al. (1990), we use this dynasty structure to construct a growth model based on aggregate human capital. Unlike all other papers in the literature, we insert this structure into an endogenous growth model—a là Lucas (1988)—with increasing returns to aggregate human capital in production. We work out a particular balanced growth path and perform our analysis across steady state solutions. Our model produces two main predictions. As the degree of increasing returns to human capital in traditional production technologies falls,

1. the population growth rates decline steadily, whereas the growth rates of per capita consumption display a *U*-shaped pattern; and
2. negative population growth and positive growth in per capita consumption can coexist.

The first result says that when the increasing returns to human capital in traditional production technologies are large, both the per capita consumption growth rate and population growth rate are fairly high. As the increasing returns move down, the growth rate of per capita consumption follows a *U*-shaped pattern. It is always positive. However, the population growth rates fall steadily and can record negative numbers after reaching a threshold. The second result follows immediately.

The *first* question is: Is there any empirical evidence that increasing returns to human capital have been falling throughout the world and are positively correlated with population growth rates? We perform an empirical analysis in Section 3 and our answer is yes. Using educational attainment data from Barro and Lee (2010), and for a sample of the biggest 50 countries in terms of per capita consumption, we show that population growth rates and the returns to human capital are positively correlated. Moreover, we provide time-series evidence that the degree of increasing returns to human capital has been falling over time. These results are in line with the literature arguing that population growth rates and the returns to human capital are positively related [Glaeser et al. (1992), Kremer (1993), and Glaeser (1999)]. Our estimates also show that the growth rates of per capita consumption follow a *U*-shaped pattern as the degree of increasing returns to human capital falls. These estimates are robust since we carry out empirical analysis in various dimensions including the time-series, panel-data, and cross-sectional perspectives, all of which yield similar results. These analyses provide empirical confirmation that our theoretical results are sensible.

The motivation behind modeling the decline in the degree of increasing returns to human capital in traditional production technologies comes from the literature investigating the population structure in cities. Population in large cities starts going down after reaching a peak point [Williamson (1965), Hansen (1990), and Henderson (2003)]. This deconcentration happens for two reasons: (i) the economy spreads knowledge to hinterland areas, or (*ii*) cities become overcongested for the inhabitants. This regularity documented in empirical work including El-Shakhs (1972), Alonso (1980), Wheaton and Shishido (1981), Junius (1999), and Davis and Henderson (2003). Our theory is the macroeconomic counterpart of this argument.

The *second* issue is about how the model works. Traditional technologies are characterized by labor-dependency in production. When the increasing returns to human capital are large, the role of human capital on the aggregate productive capacity is so highly significant that the society can afford the cost of human capital used in producing children. Children will start working when they grow up. In traditional production technologies, labor is complementary to human capital. Thus, greater human capital stock generates greater work force and the economy grows as a whole. As the degree of increasing returns to human capital in traditional production technologies starts decreasing, the positive gap between the returns from human capital and the cost of producing it decreases. This makes the growth rates of human capital (and, therefore, the growth rates of per capita consumption) decline. The complementarity between human capital and labor effort drives the population growth rates down. The endogenous efficiency-augmenting mechanism leads to the emergence of alternative labor-saving production methods. These methods liberate the gains in productivity from the counterbalancing effects of population. After a certain threshold, the population growth rates read negative numbers. Eventually, we reach a point where the degree of increasing returns are low, population declines, and per capita consumption (and human capital) grows. This mechanism paves the way for accelerated human capital accumulation and the emergence of the modern state of sustained economic growth. Kosai et al. (1998) argue that such a mechanism should necessarily work for the potential coexistence of sustained economic growth and declining population without explicitly describing the mechanism. Our paper proposes one such mechanism.

What justifies the emergence of such a mechanism? Think of the banking sector. It used to be one of the most labor-intensive sectors. Parallel to the rapid development of the internet technology, the sector now trends toward a concept called branchless banking. Another example is the transformation that the technologies producing household durables and other high-tech commodities have undergone. In Japan, human involvement in production and quality-control stages in most plants are literally zero. It is possible to extend the list of examples. This transformation leads to the emergence of alternative production technologies. In other words, the continuous increase in the productive capacities of these alternative technologies supports lower population growth rates. Our model argues that all these developments are endogenous.

The *third*, and the last, question is: why is this progress? We contribute to the literature in two dimensions. (*i*) We show that the decline in the degree of increasing returns to human capital drives population growth rates down to negative levels in the developed countries. This result is important because it reconciles two competing views. On the one hand, the traditional growth literature says that a larger population may hamper economic growth because of the diminishing returns from more intensive use of land and other natural resources [Krugman (1991) and (Ciccone and Hall, 1996)]. On the other hand, the urban economics literature argues that population growth and economic growth are positively related since larger populations encourage greater specialization and increased investment in knowledge [(Kremer, 1993) and (Glaeser, 1999)]. These two views have long been argued as being rival [see Becker et al. (1999) for an explanation why these views are believed to be rival]. Our paper shows that these two are related issues and they can co-habit in a single model. (*ii*) We propose an endogenous growth model which shows that a declining population and sustained economic growth in per capita terms can coexist. This result suggests that a declining population is not such a big problem when the individual well-being is concerned. Note that, in a standard Barro–Becker model with exogenous growth [see Section 9.2.2 in Barro and Sala-i