Financial Markets, Fertility Choices, and Economic Development (Preliminary)

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Abstract

For centuries, the pattern of economic development across the world took the form of relatively stable living standards and growing populations. Since about 1800 A.D., real per incomes have been increasing in a growing number of countries. We argue that changes in the pace of technological progress had very little to do with this phenomenon. Instead, our hypothesis emphasizes the role of institutional reforms that have faciliated the proliferation of retail banking systems.

1 Introduction

The growth in material living standards (real per capita income) that we observe in many economies today is a relatively recent phenomenon, beginning roughly in 1800 A.D. Although precise measurements are not available, it is commonly believed that living standards did not change by very much across the planet for centuries prior to this point in time. Furthermore, the dispersion in living standards across rich and poor countries prior to 1800 A.D. did not vary by much more than a factor of two. Over the last century, however, this difference in living standards has increased to a factor of thirty. The question addressed in this paper is the following: Why do recent patterns of economic development differ so dramatically from what we have observed over most of human history?

The transition of some economies from a long history of relatively stable per capita income to a recent history of rising per capita income is often attributed to the rapid pace of technological innovation that occurred during the so-called industrial revolution. Likewise, the inability of some countries to grow in terms of per capita income is sometimes attributed to a failure of these countries to adopt frontier technology. There is obviously an element of truth to this 'explanation,' but it suffers from a serious defect. In particular, we know from the work of Moykr and others that ongoing (if erratic) and significant technological progress has been with us since the dawn of recorded human history. If technological progress is the 'cause' of rising living standards, why did living standards remain largely unchanged for the centuries prior to 1800? Likewise, many of the so-called 'lesser-developed' economies of today employ technologies that are vastly superior to those employed by their ancestors (e.g., synthetic nitrogen fertilizers in agriculture) and yet average living standards in some of these economies have improved only modestly.

Population dynamics appear to play an important role in the observations described above. Historically, it appears that technological progress has manifested itself primarily in the form of larger populations, than any permanent increase in living standards. More recently (say, over the last century), the same appears to be true in many 'third world' countries. These secular population and per capita income dynamics are consistent with standard Malthusian reasoning (e.g., Miller and Upton, Chp. 1). But of course, the Malthusian model is inconsistent with the persistent growth in per capita income enjoyed by a growing number of economies since 1800. What was the nature of the change in this subset of economies that allowed them to break free of their Malthusian shackles?

In this paper, we hypothesize that the key development responsible for rising per capita incomes are innovations that facilitate the operation of financial markets. That is, we make an important distinction between technological advances that improve production methods (e.g., the wheelbarrow, the heavy plow, wind and water power, the horse collar, gunpowder, hydraulic engineering, etc.) and innovations that give rise to well-functioning debt markets. While some of these latter innovations may have been technological in nature (e.g., the mechanical clock, better communication and record-keeping systems, etc.), we conjecture that the most important innovations along this dimension have been *institutional* in nature (e.g., the appearance of legal systems with the willingness and ability to enforce the terms of private debt contracts).

Of course, financial markets have been in existence long before 1800

A.D. But prior to this time, the general availability of these markets were restricted to governments and large commercial enterprises (e.g., sailing expeditions) who issued large debt instruments purchased by a relatively small number of wealthy individuals. For the vast majority of individuals (even to this day in lesser developed economies), saving in the form of financial instruments was not an economically viable option, since the repercussions of defaulting on debt owed to the poor and powerless were likely very small. Consequently, for the vast majority of households, saving (in particular, retirement saving) had to take other forms. Historically, it appears that the primary means of retirement saving took the form of an investment in the number of children. Thus, the high fertility rates observed in lesser developed economies is likely tied to the absence of opportunities to save through the accumulation of financial instruments.

Probably the most important financial innovation responsible for breaking the link between fertility choices and saving decisions was the appearance of a well-functioning *retail* banking system (brought about by institutional changes that allowed the efficient enforcement of demand deposit liabilities for even small depositors).[1] According to our hypothesis then, the key innovation during the so-called industrial revolution was not the rapid pace of technological innovation (although this was certainly important), but the appearance of a financial market that allowed the poor to save in ways other than investing in family size. Likewise, the relatively low levels of per capita income (and large populations) characteristic of many underdeveloped economies today is not because of an apparent unwillingness or inability to adopt technological innovations (indeed, we argue that their large populations are attributable to their willingness and ability to do just this), but rather to their inability to foster institutional reforms that would facilitate the operation of financial markets (i.e., primarily retail banking).

2 A Simple Model

2.1 People

Consider an economy consisting of 2-period-lived overlapping generations. A representative 'young' household has preferences given by:

$$U_t = u(c_t(1)) + v(n_t) + \beta u c_t(2), \tag{1}$$

[1] We emphasize retail banking as something distinct from the commercial banking system already in place for centuries, that catered primarily to relatively few wealthy interests.

where $c_t(i)$ denotes consumption by generation $t = 1, 2, ..., \infty$ in the j^{th} period of life; $j = 1, 2$, and n_t denotes the number of children created by a young household. Assume that $u'' < 0 < u'$ with $\lim_{c \to 0} u'(c) = \infty$. The function v is assumed to be quadratic, with $v'(1) = 0$ and $v''(n) < 0$ (all the direct costs and benefits of child-rearing are subsumed in the function v). This latter assumption captures the idea that, in the absence of other considerations, parents are content to replicate themselves in numbers. The parameter $\beta > 0$ measures the weight that young households place on their future consumption.

Let N_t denote the (positive) measure of young households alive at date t. The initial population N_1 is given. The population of young households grows according to:

$$N_{t+1} = n_t N_t, \tag{2}$$

so that the total population at each date is equal to $N_t + N_{t-1}$. Of course, the appropriate interpretation of n_t in equation (2) is that it represents the average fertility choice of young households (so that individual households do not view their own fertility choices as influencing the economy's population growth rate in any measurable way). In equilibrium, individual choices and averages will correspond.

There is also a generation consisting of the 'initial old' who (as of date 1) care only for $c_0(2)$, with population N_0. And finally, we assume the existence of 2-period-lived 'entrepreneurs,' who are wealth maximiziers (i.e., have preferences that are linear in time-dated consumption). Assume that there is a countable infinity (zero measure) of entrepreneurs in existence at each date.

2.2 Technology and Endowments

Each young household is endowed with one unit of time that can be allocated as work in one of two sectors: the 'home' sector and the 'market' sector. One unit of labor in the home sector generates $\omega > 0$ units of output, where ω is a parameter. We think of this technology as representing a 'subsistence level' technology that places a lower bound on living standards. Let M_t denote the number of young households employed in subsistence level activities.

Production in the 'market' sector is governed by the technology $Q_t^m = zF(L, E_t)$, where Q_t^m denotes output, L denotes a fixed stock of land, E_t denotes the measure of young households employed in this sector, and $z > 0$ is an exogenous technology parameter. The function F is strictly increasing and concave in each argument; and is linearly homogeneous in (L, E). Exploiting this latter property, define:

$$f(E_t) \equiv F(L, E_t). \tag{3}$$

Clearly, $f'(E) < 0$. In what follows, we assume that the return to land accrues to those who work on it (i.e., land is owned in common by young households employed in the market sector and then is left for future generations).

Finally, output can also be produced in a sector that requires physical capital only (a capital-intensive sector). Production in this sector is governed by the technology $Q_t^n = \rho K_{t-1}$, where Q_t^n denotes output, K_{t-1} denotes the stock of physical capital, $\rho > 1$ is an exogenous technology parameter measuring the return on capital. Assume that this technology is operated by old households.

The initial capital stock K_0 is owned by the initial old and capital is assumed to depreciate fully after its use in production. New capital is produced by entrepreneurs. In particular, k_t units of investment at date t yields k_t units of capital at date $t+1$. This future capital is rented (sold) to the old households operating capital-intensive production methods.

2.3 Markets

Let (w_t, r_t) denote the wage rate and the rental rate for capital, respectively. Since factor markets are competitive, individuals take these prices parametrically. Since the labor of young households is freely mobile across the 'home' and 'market' sectors, the real return to labor must satisfy:

$$w_t = \max\left\{zf(E_t), \omega\right\}. \tag{4}$$

Now, observe that since entrepreneurs have no means of self-financing investment, they must borrow the required resources from young households. The need to borrow (and the desire to lend) implies an obvious role for the operation of a financial market (i.e., a market for private debt). We assume that entrepreneurs face a debt constraint of the following form:

$$k_t \leq \kappa, \tag{5}$$

where $\kappa \geq 0$ is an exogenous parameter indexing the technological efficiency of the private debt market. The idea behind (5) is that entrepreneurs cannot commit to repaying debt so that debt repayment is governed by the effectiveness of the prevailing legal/institutional structure of an economy. Institutional environments that are not conducive to the enforcement private debt contracts can be modeled by 'small' values of κ (in the absence of any commitment power, $\kappa = 0$ and no capital investment takes place). Likewise, a technological improvement in the financial market can be thought of manifesting itself as an increase in κ.

The market for private debt is also competitive. Anticipating some equilibrium behavior, competition among (the countably infinite) entrepreneurs will drive the (gross) real interest rate in line with the future return on capital, $r_{t+1} = \rho$. In equilibrium, entrepreneurs will consume zero in each period and consequently may be ignored for the remainder of the analysis.

3 Intergenerational Transfers

Notice that the debt constraint (5) faced by entrepreneurs essentially translates into a 'saving constraint' as far as young households are concerned. In the extreme case where $\kappa = 0$, saving in the form of (debt instruments that represent claims against) physical capital is infeasible. In the absence of any saving, consumption during old age would fall to zero.

When capital investment is severely constrained, it may be desirable for agents to enter into an intergenerational transfer scheme with young households supporting their parents at each date into the indefinite future. One way to formalize these intergenerational transfers is to introduce what Samuelson (1958) refers to as the 'social contrivance' of fiat money; or, equivalently, a government operated pay-as-you pension program.

However, we prefer to view of these intergenerational transfers as occurring through a more descriptively accurate mechanism. For probably most of human history (including the present in lesser developed economies), the primary form of retirement saving has been through the 'investment' parents made in terms of family size (i.e., the number of children). A 1984 World Bank report puts it this way:[2]

> All parents everywhere get pleasure from children. But children involve economic costs; parents have to spend time and money bringing them up. Children are also a form of investment–providing short-term benefits if they work during childhood,

[2] Quoted from Razin and Sadka (1995, pg. 5).

> long-term benefits if they support parents in old age. There are several good reasons why, for poor parents, the economic costs of children are low, the economic (and other) benefits are high, and having many children makes economics sense.

In our model, the direct costs and benefits of child-rearing are captured by the function v. We introduce an added pecuniary benefit of having children by supposing that when children become adults, they face choice as to whether to support their (now aged) parents with a transfer that is proportional to their current income w_t by the fraction $0 < \theta < 1$. In what follows, we treat θ as an exogenous parameter (i.e., perhaps determined by culture, custom, or evolutionary forces). But whether the transfer occurs or not is endogenous. In particular, generations are assumed to play a 'tit-for-tat' strategy whereby children mimic the altruism of their parents (toward their own parents). In this way, a young household that 'reneges' on its transfer to its own parents can be expected to be treated similarly by their own children. As is well-known, tit-for-tat strategies satisfy the Nash solution concept.

Thus, in the absence of capital, a representative young household faces the following choice problem

$$\max u(c_t(1)) + v(n_t) + \beta u c_t(2)$$

subject to:

$$\begin{aligned} c_t(1) &= (1-\theta)w_t; \\ c_t(2) &= n_t \theta w_{t+1}. \end{aligned}$$

or:

$$\begin{aligned} c_t(1) &= w_t; \\ c_t(2) &= 0. \end{aligned}$$

Note that for a sufficiently large θ, the young household may find it optimal to abandon the intergenerational transfer convention. Let us assume, however, that this is not the case (i.e., θ has evolved to some 'reasonable' value). In this case, the optimal fertility choice n_t satisfies:

$$-v'(n_t) = \theta \beta w_{t+1}. \tag{6}$$

Condition (6) implies that $v'(n_t) < 0$ so that $n_t > 1$. In other words, as long as children are the only means to retirement saving, parents will find it optimal to have 'excessive' numbers of children (i.e., more children than would be required to keep the population stable).

Combining equation (6) with equation (4), we have:

$$-v'(n_t) = \theta\beta \max\{zf(E_{t+1}), \omega\}.$$

There are two possibilities to consider. First, suppose that ω is 'small' so that $E_{t+1} = N_{t+1}$ implies $zf(N_{t+1}) > \omega$. In this case, we have:

$$-v'(n_t) = \theta\beta zf(n_t N_t). \tag{7}$$

According to (7), the equilibrium fertility rate in this case is increasing in z and decreasing in N_t. In the former case, an exogenous technological improvement leads to higher future wages (*ceteris paribus*) thereby increasing the attractiveness of children as an investment. In the latter case, an exogenous decline in population (say, due to disease or war) has the same effect, since there is now a smaller population working the same amount of land. In the absence of any exogenous shocks, equation (7) implies that the population continues to expand over time, driving the real wage to lower and lower levels.

As the process above continues, the real wage will eventually fall to its lower bound, ω. In this case, the equilibrium fertility rate is determined by:

$$-v'(n_t) = \theta\beta\omega; \tag{8}$$

and the population of young workers divides itself across the home and market sectors in the following way:

$$\begin{aligned} \omega &= zf(E); \\ M_t &= N_t - E. \end{aligned} \tag{9}$$

In this case, the return to work in the market sector is driven down to subsistence wages and further increases in the population manifest themselves as employment increases in the subsistence level activity.

In the absence of any exogenous shocks, conditions (8) and (9) describe the 'steady-state' of this economy. Exogenous improvements in technology (or exogenous declines in population) may (or may not) temporarily 'kick' the economy back into the scenario described by equation (7), leading to a short-run improvement in living conditions. In the absence of any such forces, however, the economy is inexorably drawn to the 'Malthusian' outcome of subsistence wages.

4 Financial Markets

In the last section, we assumed $\kappa = 0$. In this section, we will consider the opposite extreme; i.e., $\kappa = \infty$. This latter case corresponds to a situation where debt markets work perfectly well, so that entrepreneurs face no debt constraint (beyond what budget balance in a present value sense would entail).

With a well-functioning financial market, young households need not (and, indeed, will not) view one of the benefits of children as a source of retirement income. As a thought experiment, imagine that the economy is initially in the 'Malthusian' steady state described in the previous section, with a real wage given by ω. Imagine then the arrival of a technological (or institutional) innovation that suddenly opens up the possibility of saving via financial instruments (i.e., κ switches from zero to infinity).

The young household's constraint set is now given by:

$$\begin{aligned} c_t(1) &= (1-\theta)w_t - k_t; \\ c_t(2) &= \rho k_t + n_t \theta w_{t+1}. \end{aligned}$$

or:

$$\begin{aligned} c_t(1) &= w_t - k_t; \\ c_t(2) &= \rho k_t; \end{aligned}$$

where the first set of constraints are associated with keeping the intergenerational transfer scheme in place, while the second set of constraints implies abandoning intergenerational transfers.

If the return on capital ρ is sufficiently higher than the return on children as investment $\theta\omega$, it will be optimal for the young generation to abandon the convention of intergenerational transfers. In this case, optimal decision-making is characterized by:

$$\begin{aligned} v'(n_t) &= 0 \Rightarrow n_t = 1; \\ u'(w_t - k_t) &= \rho\beta. \end{aligned}$$

The key thing to note here is that the choice of family size is now divorced from the saving decision. As a consequence, the population remains constant (barring exogenous shocks to population size) at its 'initial' level, $N_t = N$.

Assuming $u(c) = \ln c$, the optimal level of investment is given by:

$$k_t = w_t - (\rho\beta)^{-1}. \tag{10}$$

Since $w_t = \omega$ initially, we have $k_t = \omega - (\rho\beta)^{-1} > 0$ (by assumption). In the absence of any further technological developments, the population and its division across sectors remains constant; i.e., $E_t = E$, $M_t = M$, and $N_t = N = E + M$.

In the period of the financial innovation (and in prior periods), real per capita GDP y_t is given by:

$$\begin{aligned} y_t &= \frac{N_t}{N_t + N_{t-1}}\omega; \\ &= \left(\frac{1}{1+n_t}\right)\omega, \end{aligned}$$

where $n_t > 1$ is a constant defined by equation (8). In the periods following the financial innovation, real per capita GDP is given by:

$$\begin{aligned} y_t &= \frac{N_t}{N_t + N_{t-1}}\omega + \frac{N_{t-1}}{N_t + N_{t-1}}k_{t-1}; \\ &= \frac{1}{2}\omega + \frac{1}{2}k_{t-1}; \end{aligned}$$

where k_{t-1} is given by equation (10). Thus, the financial innovation alone (i.e., in the absence of any other productivity improvement), leads to a permanent increase in the level of real per capita GDP. It does so for two reasons. First, population growth rates fall; and second, capital investment that matures now adds to total production.

In the Malthusian economy modeled in the previous section, the occasional arrival of technological improvements (increases in the parameter z) could at best improve living standards only in the short-run. Inevitably, economic forces would drive wages back down to subsistence levels in the long-run. But the behavior of the economy in response to the *same pattern* of technological advances is now very different when financial markets are present.

Beginning in an initial condition that implies $w_t = \omega$, the effect of an exogenous increase in z is to draw workers out of subsistence activities into market activities (leaving the population unchanged). When productivity rises to a high enough level, the demand for labor exceeds the supply of workers at the wage ω (at this point, all households wish to work in the market sector, leaving their subsistence activities behind). When this happens, the real wage must rise. As the real wage rises, so does capital investment. Thus continued improvements in z now manifest themselves not as higher populations, but as higher per capita incomes (as both wage and capital income increases).