Long-Run Growth and Demographic Transition

Social classes, demographic transition and economic growth

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Abstract

This paper analyzes the role of the demographic transition in the emergence of sustained economic growth, and shows that these two processes are related. Unlike previous contributions which have focused on the importance of human capital, this paper suggests that capital accumulation, and the existence of different social classes may provide an alternative explanation for the observed pattern of output, fertility rates and wages during the 19th century. The framework presented shows that during the first phase of industrialization, a decline in capital–labor ratio reduces the wage rate and increases the dependency of the family unit on child labor, increasing fertility rates. However, in later phases the increase in the capital–labor ratio, due to the saving of the business elite, reduces the necessity of child labor bringing about the demographic transition. © 2001 Elsevier Science B.V. All rights reserved.

1. Introduction

Demographic transition has lately been the focus of interest amongst scholars in the field of economic growth. Although for decades, demographic historians

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have compiled impressive data about the demographic transition that took place for the most part, over the 19th century,[1] research in the field of economic growth has neglected the important role that the demographic factor may have played in economic growth. Recently, however, the link between the Industrial Revolution, the demographic transition, and sustained economic growth has been analyzed by Galor and Weil (1996, 1999, 2000) and Dahan and Tsiddon (1998).[2]

Unlike these recent models that underline the role of human capital in the onset of the demographic transition and economic growth, this paper will develop a model about the connection between demographic transition and economic growth, based upon capital accumulation. The structure of the model will be based on assumptions that fit the descriptive writings of the period, and more specifically those of Karl Marx (1818–1883), a major writer and observer of economic and social behavior in the 19th century. The three main elements emphasized by Marx were: *Capital*, *Social Classes and the Labor Market*. They may provide an explanation for the observed pattern of fertility rates and industrialization.

Research on the Industrial Revolution has shown that capital was a preponderant factor of production during the industrialization of England. This brings to mind that Marx's famous book, written in the 19th century, was called *Das Kapital* and not *Das Human Kapital*.[3] Moreover, growth accounting for England during the 19th and 20th centuries has shown that, during the 19th century, the growth in GDP is explained mainly by capital and labor, while only in the 20th century Total Factor Productivity (TFP) and human capital become substantial.[4]

The second element that is fundamental to the understanding of the 19th century is social classes. On one hand, there is the proletariat which is termed by Marx as the 'reserve army labour', and on the other hand, there is the bourgeoisie – 'the business elite'. The main difference between these two social groups is that the proletariat received such a low wage that, in the 19th century, was merely sufficient for survival, while the business elite accumulated capital, and increased it over the century, via saving (*à la* Kaldor).

This difference leads to dissimilar economic behavior of the two groups; their decision regarding consumption, as well as their decision regarding children and the size of the family are distinct. Incorporating this difference into one model

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[1] See Andorka (1978), Wrigley and Schofield (1981), Coale and Watkins (1986), and Bardet and Dupaquier (1998).

[2] See Morand (1999) as well.

[3] The latest is a contribution written at the end of the 20th century by Galor and Moav (2000).

[4] See Brezis (1999). However, there is also an increase at the end of the 19th century in the number of years of schooling (see Galor and Weil, 2000).

allows us to analyze the interactions between these two groups, and its effect on the process of development.

The third element that is dissimilar in the 19th and 20th centuries, is the relationship between family and the labor market. The notion of altruism inside the family as it is perceived today is relatively a new one. An examination of literary fiction published during the 18th and 19th centuries reveals that paternal altruism is not relevant over the period, while maternal love is a notion that starts to emerge in the literature of the 19th century. (However, women were not recognized as a legal entity and did not take decisions for the family. Even a liberal like John Stuart Mill wrote that women should live in total abnegation and should have no autonomy!)

We should not be astonished, therefore, that in the 19th century, Marx emphasized that children are an investment good. More precisely, the Marxist view suggests that the 'proletarianization' of the workforce (a term coined by Tilly) brings on a fertility increase since the working masses attempt to accumulate the one factor of production they do control – labor power. While some models of fertility (starting with the works of Becker (1960), Becker and Barro (1988) and Becker et al. (1990)), are based on altruism which assumes that children are a consumption good; for Marx, children were a necessity for survival and not a consumption good.

For the business elite, the values on which the family is based are: *l'argent de famille*. In this social class, respect and honor from peers come if one makes his business fruitful. The whole family is mobilized to this end – that is, to the family business. In other words, if for the proletariat, children expanded the family income, for the business elite, children were the way in which to continue the family business, and ensure its survival.

Our proposed model, based on these three elements, will permit us to analyze the connections between the dynamics of the fertility rate and economic growth that occurred during this period. It will allow us to clarify the relationship between the fertility rates across different classes since it analyzes the behavior of both the proletariat and the elite. The model's dynamics exhibits an initial increase in the fertility rates at the onset of the Industrial Revolution in both proletariat and business elite, and later a reduction of the fertility rate of the proletariat. The data show that during the 19th century, not only is the rate of fertility different between social classes, but also their dynamics, as seen in Table 1.

In models that incorporate altruism and human capital, the reduction of fertility that takes place in the second stage of the industrialization is due to the fact that when education is better rewarded, agents prefer to have fewer and more educated children, than more non-educated children. The story we present here is different. At the onset of the Industrial Revolution, wages went down and 'neither men nor women could subsist on their pay alone' (Hilden, 1984, p. 364). This led to a fertility increase since child labor kept family incomes large enough

Table 1
Fertility and social classes (census from 1911)

Social classes	Year					
	1851	1861	1871	1881	1891	1901
Professional	100	100	100	100	100	100
Proprietors	112	107	109	111	116	115
Skilled workers	119	121	131	141	144	132
Textile workers	114	114	121	129	125	112
Farmers	124	124	140	156	152	151

Source: Haines (1989).

to allow for consumption at the subsistence level. During the second half of the 19th century, when wages went up, workers started to reduce the number of children they desired and the fertility rate went down.

The evolution of real wages is therefore the key element in the demographic transition. They are endogenously determined by the capital–labor ratio which is in itself a function of the amount of labor (determined by the workers) and the amount of capital (determined by the business elite).[5] It is the interaction between these two classes that leads to the dynamics of growth and fertility rates. During the first phase of industrialization, despite an increase in output per capita, the workers' fertility rate is such that capital increases less rapidly than population and therefore the wages fall. During the second phase, the increase in output leads to an increase in wages and a reduction in the fertility rate of the workers.

2. The framework of the model

Society during the Industrial Revolution was comprised of many classes: workers, bourgeoisie (liberal professions such as lawyers and doctors), the 'haute bourgeoisie' (i.e., the business elite), the aristocracy (who had no economic impact on industrialization) and the farmers. This paper focuses only on the two classes that played a preponderant role during the Industrial Revolution: the proletariat and the business elite.

The structure of the model is dynamic in the sense that we have a continuity of generations; workers and entrepreneurs (the business elite) live one period in which they choose their optimal consumption level and number of children. The

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[5] In this framework we assume, for matters of simplicity, that the economy is a closed one, i.e., there are no immigration or capital inflows. In reality, this was not the case for England (see Crouzet, 1982; Brezis, 1995).

Table 2
Earnings and cost of living for workers in Lille for the years 1885–1911 (Francs per year)

	Earnings	Cost of living
1885	1320	1635
1893	1420	1491
1896	1272	1397
1902	1420	—
1906	1444	1181
1911	1358	1234

Source: Hilden (1984).

utility function across social classes is different since the workers during the 19th century had an income that did not allow them to save at all; the model therefore restricts itself to the period where real wages were not higher than consumption. Moreover, since the size of the elite population is negligible, the size of the population is equal to the size of the workers population.

2.1. The proletariat

In the case of the proletariat, fertility is related to the 'family wage'. Tilly and Scott (1989) emphasized that industrialization led to a change in family structure. During the pre-industrial period, all members of the family were producing and consuming together in the framework of a structure called the 'family economy'. The factory system of production during industrialization, however, destroyed this family economy. Families did not decide anymore on the division of work between its members. In the factory system, each member of the family brought in a wage; the family structure became the 'family wage'. Since the salary of one person was not enough for subsistence, having children brought about an increase in the family income. Table 2 provides data showing that the earnings of a couple were indeed not enough to survive. (The data is for France, but the situation was similar for workers in British factories during the first century of industrialization.)[6]

In each period, workers choose the number of children that allows them to reach the subsistence level of consumption. The budget constraint of the family in each period is therefore

$$\bar{C} + l(n^w) = w + wn^w. \tag{1}$$

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[6] See Coats (1972). Moreover, Basu and Van (1998, p. 416) take it for granted that 'a family will send the children to the labor market only if the family's income from non-child labor sources drops very low'.

Table 3
Fertility rate, wages and the ratio of capital over labor in England, during the 19th century

	Ig (fertility rate)	Real wages	Real wages in the cotton industry	K/L in the industrial sector
1800	0.65	95	98	396
1810	0.65	124	76	383
1820	0.65	110	53	375
1830	0.65	101	<u>45</u>	<u>335</u>
1840	0.66	100	49	340
1850	0.67	<u>100</u>	52	346
1860	0.67	103	68	378
1870	<u>0.68</u>	118	81	400
1880	0.65	134	87	420
1890	0.62	166	95	434

Sources: Bardet and Dupaquier (1998); Mitchell and Deane (1971); Feinstein (1981); Maddison (1995).

$\bar{C}$ is the subsistence level of consumption for an adult, n^w is the number of children the worker has, and $l(n^w)$ is the consumption of children. We assume that $l(n^w)$ is upward sloping and concave.

On the right-hand side we have family income. This includes worker's wage as well as children's wages. Wages of children were, in reality, lower than wages of adult (about half in the textile industry), but just to simplify the model, we take all wages as equal.

The workers choose the minimum number of children, such that equality in Eq. (1) is obtained, and therefore the number of children is

$$n^{w*} = n(w) \quad \text{and} \quad \mathrm{d}n^{w*}/\mathrm{d}w < 0. \tag{2}$$

Eq. (2) implies that when wages decreased, as happened during the first half of the 19th century (see Table 3), families needed more children to survive, and fertility rate went up. During the second half of the century, wages went up and therefore workers reduced their fertility rate.

2.2. Output

The two main factors of production are capital, K, and labor, L, and the output function takes the form

$$Y_t = A K_t^{\alpha} L_t^{1-\alpha}. \tag{3}$$

Since we assume a constant return to scale Cobb–Douglas function, we get wages as an increasing function of the capital–labor ratio (where the second derivative is negative).

The interaction between the decisions of workers and the output function leads to a relationship between the fertility rate of the workers and the capital–labor ratio. As we saw in the preceding section, the fertility rate of the workers is a (negatively sloped) function of wages, and wages are a (positively sloped) function of the capital–labor ratio. Therefore, in each period the fertility rate is a negative function of the capital–labor ratio as expressed in

$$n_t^w = \Delta(K_t/L_t), \quad \text{where } \partial n_t^w/\partial (K_t/L_t) < 0. \tag{4}$$

This relationship between the fertility rate and the capital–labor ratio is the first result of our model. It stems from two main assumptions. The first is that the children are an investment good, i.e., their work is necessary for subsistence. The second is that the output function displays diminishing marginal returns to capital. The second result of our model is about the dynamics of the capital–labor ratio; we therefore turn now to examine the decisions taken by the elite, i.e., the social class that owns capital.

2.3. The business elite

In the previous section, the fertility rate of the proletariat was related to the level of wages. Entrepreneurs do not have the problem of survival that the proletariat has, since their consumption is well above subsistence level. Why then, would the business elite care about the number of children they have? The reason is uncertainty.

We have shown that the elite was concerned about the family business but, as emphasized by Crouzet (1999, p. 46): 'Dynasties also demand what can be called biological continuity ... Some business dynasties have disappeared for lack of heirs'. Since mortality remained high during the 19th century, and the survival of the firm is a function of the number of children they have; so the higher the number of children, the higher the probability of survival.

Upon examination of the fertility rate amongst the business elite in England (and also in France), we find that it was higher than in the other classes. As an example, Sir John Guest had 10 children, and William Crawshay had 14 (they belonged to dynasties of entrepreneurs in the iron industry). The André and the Schneider dynasties disappeared because of a small number of children (3) that died with no offspring.[7] (Among the bourgeois, i.e., the liberal professions, the fertility rate, on average, was lower.)

The utility function of the elite is a function of consumption, C_t, and the increase in the value of the firm. The increase in the value of the firm is due to the saving of the entrepreneur, S_t. The value of the firm is not known with certainty, since it depends on whether the dynasty has offspring. Therefore, the elite

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[7] See Crouzet (1999) and Lewis (1986).

maximizes an expected utility. When the elite has children that can take over the firm, the utility of the savings is $U(S_t)$; when there are no children, savings are lost and we obtain that the utility of savings is zero.

Denoting p, as the probability of survival of the firm, we assume that

$$p = p(n^{\mathrm{b}}) \quad \text{where } p' > 0 \text{ and } p'' < 0, \tag{5}$$

where n^{b} is the number of children per family in the business elite.[8] Therefore, the expected utility is

$$EU = U(C_t) + p(n_t^{\mathrm{b}})U(S_t). \tag{6}$$

We assume that each generation lives one period. The income of the entrepreneur is the rents he gets on the inherited capital, $r_t K_t$. He divides his income between his own consumption, the consumption of his children and savings, S_t.

We assume that a share f of the total consumption goes to the children's consumption (and a share $1 - f$ to his own), and the $f(n_t^{\mathrm{b}})$ function is negatively sloped and convex, so that the higher the number of children, the lower his own consumption.

Substituting C_t into Eq. (6) results in the entrepreneur choosing savings and number of children so as to maximize

$$U[(r_t K_t - S_t)f(n_t^{\mathrm{b}})] + p(n_t^{\mathrm{b}})U(S_t). \tag{7}$$

The amount of savings, consumption and children chosen by the entrepreneur are determined from the first order conditions. When, more specifically, the utility function takes a logarithmic form, we get that savings are a linear function of rents, $r_t K_t$, and that the number of children is a function of the capital stock, K_t.

3. Equilibrium and dynamics of capital, wages and fertility rates

3.1. Equilibrium

At the beginning of the period, the amounts of capital and labor are given; this determines the wages received by the workers and their fertility rate (see Eq. (4)). On the side of the business elite, capital and interest rates determine their savings and their own fertility rate. In order to see over time what happens to these two fertility rates, one has to analyze the dynamics of the system.

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[8] This probability is also function of the mortality rate, but since it is exogenous in our framework, we omit it.

3.2. Dynamics

The number of children in each family of workers determines the population in the next period (since the elite population is negligible), while the savings of the elite determines the stock of capital. It can be shown that an increase in the capital–labor ratio occurs if and only if the savings–capital ratio, S/K, is greater than the increase in population, n^{w}. The dynamics of the model are that when the savings–capital ratio is smaller than the increase in population, then the increase in the capital stock is lower than the increase in population. In consequence, the capital–labor ratio decline and wages in the next period will be lower than in the first period. The fertility rate will increase as a result. When the situation is reversed we get a decrease in the fertility rate.

A comparison of the savings–capital ratio and the fertility rate of the workers is possible since both variables are a function of the capital–labor ratio. Under some assumptions already mentioned, at the initial capital–labor ratio, n^{w} is greater than S/K, so that the capital–labor ratio is decreasing. This situation continues until the system reaches a steady state where n^{w} is equal to S/K. This is a steady state, a priori, and there are no changes in the capital–labor ratio and in wages. The variable that, at this point, drives the system to continue to move is the fertility rate of the entrepreneurs, n^{b}, since it is a function of capital that is still continuing to increase. From then on, the trajectory is a movement along the curve described by Eq. (4) (that represents n^{w} as a function of K/L). Over time capital–labor ratio increases and as a result the fertility rate n^{w} decreases.

Our proposed model framework generates two results: The first is that when the capital–labor ratio declines we obtain a reduction in wages and an increase in the fertility rate of the workers, while when the capital–labor ratio increases we get an increase in wages and a decrease in the fertility rate of the workers. The data presented in Table 3 show that these relationships existed in the 19th century when there was a negative correlation between wages (or the capital–labor ratio) and the fertility rate of workers.

The second result is that during the first phase, the capital–labor ratio decreases since n^{w} is greater than S/K. Later on, and over time, the capital–labor ratio increases. As shown in Table 3, during the first half of the 19th century, we indeed get a decrease in the capital–labor ratio (and an increase in fertility), while in the second half of the century, the capital–labor ratio increases.

4. Conclusion

This paper follows the line of reasoning seen in Galor and Weil (1999, 2000) and argues that the demographic transition and the process of industrialization are intimately related phenomena. Unlike previous contributions, which have focused on the importance of human capital, this paper shows that the evolution

of capital, social classes and 'proletarianization' may provide an explanation for the observed pattern of output, fertility rates and wages during the 19th century. During the first phase of industrialization, despite an increase in output per capita, a decline in capital–labor ratio reduces the wage rate and increases the dependency of the family unit on child labor, increasing fertility rates. However, in later phases the increase in the capital–labor ratio, due to the saving of the business elite, reduces the necessity of child labor bringing about the demographic transition.

Acknowledgements

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