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Economic Development and Family Structure: from *Pater Familias* to the Nuclear Family*

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Abstract

We provide a theory of the interaction between intergenerational living arrangements and economic development. We show that, when technical progress is fast enough, the economy experiences a shift from stagnation to growth, there is a transition from coresidence to non-coresidence, and the social status of the elderly tends to deteriorate.

Keywords: Unified Growth Theory, Intergenerational Living Arrangements, Bargaining Power, Family Economics

JEL Classification: O40, O11, O33, J10

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1 Introduction

In this article, we propose a theory of the interaction between intergenerational living arrangements and economic growth. This theory is able to rationalize in a growth model the observed secular shift from the extended to the nuclear family.

The family structure in Western societies has undergone major changes since the nineteenth century. Figure 1 shows that in the United States the percentage of elderly residing with their adult children plummeted from 60% in 1870, to 15% in 1990. Kertzer (1995) argue that a similar drop can be observed in several European countries. A recent study from the United Nations concludes that there is a global trend, across countries and over time, towards independent forms of living arrangements for older persons (United Nations (2005)).

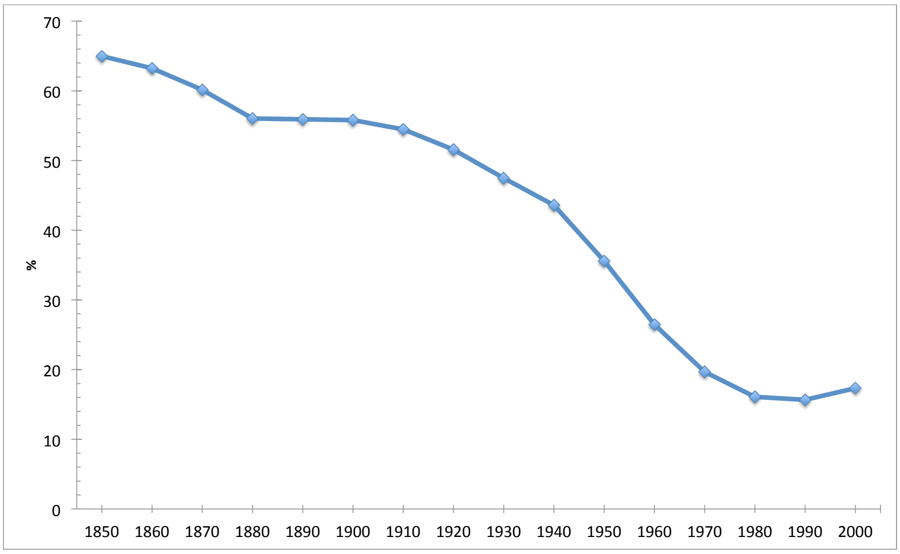

Figure 1: Coresidence rate in the United States. Percentage of elderly aged more than 65 living with at least one child aged more than 18.
Source: our elaboration on Ruggles, Alexander, Genadek, Goeken, Schroeder, and Sobek (2010). Married couples are counted as single observations. Persons living in group quarters such as rooming houses and military barracks are excluded from the sample.

Different theories have been advanced by sociologists and demographers to explain this phenomenon. The prevailing view so far is that intergenerational coresidence seems to fade away as economic development kicks in. The role of cultural factors is still disputed. The accepted wisdom is that they might play a role in influencing the rapidity and the intensity of the process, but do not seem to be crucial determinants of the process itself (Ruggles (2009)).[1]

The recorded shift in the living arrangements from coresidence to non-coresidence has often been considered by sociologists and demographers as accompanying a change in the social status of the elderly in society (Kertzer (1995)). However, social status is an elusive concept, difficult to define, and even more difficult to quantify. Several variables such as patriarchal control, relative income, education, health and psychological conditions can be thought of as proxies for social status. According to Ruggles (2007), the decline of intergenerational coresidence reflects a decline of patriarchal control. Patriarchal control was widely diffused in pre-modern societies. For instance, senators in ancient Rome were the old heads of the noble families of the city, the so-called *patres familias*. The very word 'senator' has the same root as '*senex*', which means 'old' in Latin. Patriarchal control endured and was still strong in the modern age. By comparing the legal entitlements of parents to their children's income in France, England and the United States since the seventeenth century, Schoonbroodt and Tertilt (2010) make a convincing case for the presence of a *de jure* high degree of patriarchal control in the West until as late as the nineteenth century. Thereafter a progressive emancipation of the younger generations occurred. Such a feature is a common trait between the West, China and South Asia, although it has been traditionally much stronger in the former (Thornton and Fricke (1987)). More generally, it has been argued by sociologists that the relative status of the aged, measured as relative income, education, health and psychological conditions, has diminished as modernization has taken place (see, for instance, Cowgill (1974), Palmore and Whittington (1971)).

The literature mentioned above points to a change in the family structure that occurred during, and because of, the process of economic development. The role of cultural factor is still disputed. Moreover, this literature maintains that such a change went along with, and depended upon, a diminished social status of the elderly. Our work is able to account qualitatively for the observed co-movement between the intergenerational living arrangements and economic growth, and for its connection with the

[1] See Kramarov (1995) for a different perspective.

diminished status of the elderly. Moreover, a contribution of our analysis is to provide a suitable analytical framework to assess the relative role of economic and cultural factors in causing the shift in intergenerational living arrangements.

To this end, we build an overlapping generation model (OLG), in which there is no intragenerational heterogeneity and the pattern for coresidence is endogenously determined. Drawing inspiration from Kotlikoff and Morris (1988), in Section 2 we build a set up where preferences are defined over consumption goods and living arrangements. Agents can decide either to live alone, or to coreside with their parents/siblings. When coresidence is chosen, the household is modeled as having 'pluralistic' decision-making (Bergstrom (1997)). More specifically, we assume a cooperative bargaining model leading to a Pareto-efficient solution, in the spirit of Chiappori (1988, 1992a,b).[2] Moreover, we require that the decision to coreside is always incentive-compatible for both agents. In this context, the coresidence decision turns out to be a function of the bargaining power of the young and the old, and is influenced by the utility levels that the young and the old can get from living alone. Therefore, living arrangements are ultimately determined by the taste for coresidence and the relative income of the two generations. If we assume that the young dislike coresidence but the old like it, when the relative income of the young with respect to the old is above a certain threshold a shift from coresidence to non coresidence occurs, and vice versa.[3]

In Section 3 we first illustrate the main mechanisms of the theory in the context of a model with exogenous growth. We assume that only the human capital of the young is positively affected by exogenous technological progress. Here, the implicit hypothesis, justified by a widespread literature, is that technical change is age-biased towards the young generation.[4] On the other hand, the human capital of the old generation will benefit from an experience premium of the learning-by-doing type. These

[2]Pezzin and Steinberg Schone (1997) show that the allocation decisions within intergenerational households are best modelled as outcomes of a bargaining process.

[3]Manacorda and Moretti (2006) have shown that there is a positive correlation between coresidence and the parents' income, which they interpret as evidence of parents liking coresidence. Studies by Aquilino (1990), Ward, Logan, and Spitze (1992) and Whittington and Peters (1996) have shown that there is a negative correlation between coresidence and the children's income, which is compatible with the young disliking coresidence.

[4]There are significant adoption costs linked to a new technology (Jovanovic and Nyarko (1996)). The young have more incentive to adopt the new technology, as their lifespan is longer (Ahituv and Zeira (2010)). Moreover, the old are typically more skilled at using the existing technology, which makes the opportunity costs of learning the new one possibly higher for them than for the young (Chari and Hopenhayn (1991)).

two assumptions imply that the relative income of the young with respect to the old will depend on the ratio between technological progress and the experience premium.

These elements lead us to argue that coresidence was more frequent in pre-industrial societies because of the slow technical progress that characterised those societies. If technical progress is slow, the experience premium is relatively larger. The relative income of the young is low, and therefore they gain from coresiding with the old. With the industrial revolution, and in particular with the fast path of technical progress in the twentieth century, things have changed. The relative importance of the experience premium has shrunk, while the relative income of the young has increased. In this new context, the incentives for intergenerational coresidence may eventually disappear.

Under some restrictions on the parameters, in Section 4 we go one step further by endogenizing the human capital formation. This allows us to study the feedback effect of living arrangements on the economic performance of a given society.[5] We assume that only the young care about the human capital of the child, and devote a fraction of their time to educating children. In this context, we show that when the shift in living arrangements is explained by technical change (economic factors), the model economy experiences an increase in the growth rate along a balanced growth path. On the contrary, when the shift in living arrangements is explained by changes in the taste for coresidence (cultural factors), the model economy experiences a reduction of the growth rate along a balanced growth path. We can compare these results to the available evidence. In Figure 2 we plot the coresidence rate against the growth rate of GDP in the United States. The correlation coefficient between the coresidence rate and the ten-year (twenty-year) rate of growth of the GDP per capita is -0.42 (-0.69).[6] In the light of our model, this negative correlation implies that technical progress must have played a major role in explaining the shift from coresidence to non coresidence, while the role played by changes in cultural factors must has been minor. [7]

[5] Duranton, Rodríguez-Pose, and Sandall (2008) give empirical evidence on the importance of the family structure for determining educational attainment, social capital, labor participation, sectoral structure, wealth, and inequality. Alesina and Giuliano (2010) found that the strength of family ties has a deep influence on economic behaviour.

[6] We consider growth rates on a ten-to-twenty years basis because we are dealing with OLG models with two (Section 3) or three (Section 4) periods.

[7] The evidence discussed in the main text is suggestive, and allows for a qualitative assessment of the respective roles of economic and cultural factors in causing the shift in intergenerational living arrangements. A more quantitative analysis, stating for instance how much of the observed reduction in the coresidence rate could be explained by

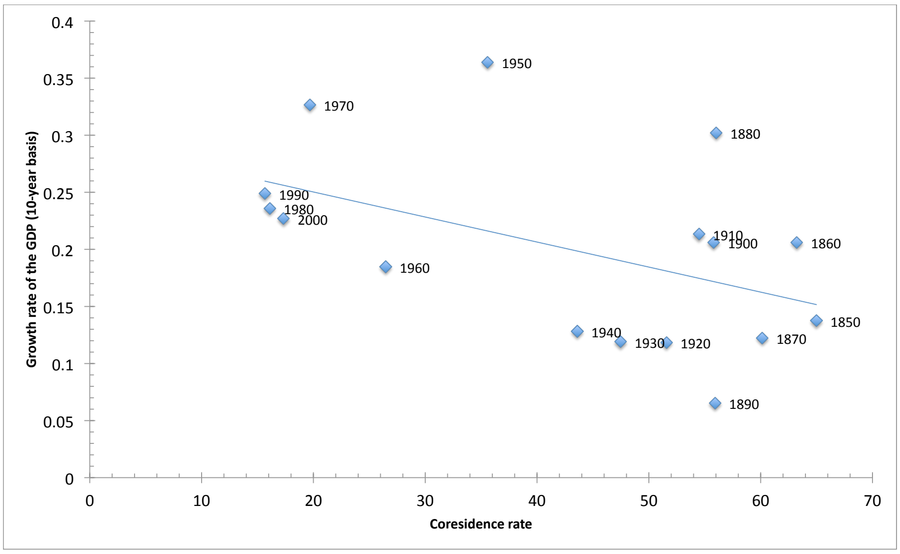

Figure 2: Coresidence and GDP growth in the United States.
Sources: GDP per capita, Maddison (2011); coresidence rate, same as in Figure 1.

Our theory also has implications for the social status of the elderly. Sticking to a narrow definition of social status, as the fraction of resources allocated to each generation, the model can predict the progressive deterioration of the social status of the elderly documented in the sociological literature.

Among the authors explaining the change in living arrangements of the elderly with economic factors, there are two main hypotheses: the 'affluence hypothesis' and the 'economic development hypothesis'. The former attributes the change in the living arrangements of the elderly to progress in medicine and the institution of the Welfare State.[8] These two factors caused an improvement in the economic conditions of older persons, thereby reducing their dependence on children. Underlying this explanation is the

economic factors, is beyond the scope of the present article. Indeed, in this work the absence of heterogeneity within the same generation implies that, in each period there is only one living arrangement chosen by everybody. In other words, the coresidence rate in this model is either 0 or 100 percent.

[8]See for instance Costa (1997), McGarry and Schoeni (2000).

idea that parents would prefer to live alone, if they could afford it. In this view, intergenerational coresidence is forced upon the elderly by the lack of alternatives. According to the economic development hypothesis, instead, things worked the other way round. Incentives for intergenerational coresidence in the past results from the needs of the children, rather than from those their elderly parents. In this view, the decline of intergenerational coresidence resulted from increasing incomes of the young and declining parental control of the old over their offspring. Ruggles (2007) argues convincingly in support of the economic development hypothesis. Our work fits into this second strand of the literature. Accordingly, in this article we abstract from the presence of public transfers.

The existing economic literature modelling intergenerational coresidence focuses on two main issues: when and why the young leave home (Ermish and Di Salvo (1997), Fogli (2004), Kaplan (2010), McElroy (1985), Rosenzweig and Wolpin (1993)); and what are the living arrangements of elderly parents (Bethencourt and Rios-Rull (2009), Pezzin and Steinberg Schone (1999), Pezzin, Pollak, and Steinberg Schone (2007), among others). The closest approach to our work is that by Salcedo, Schoellman, and Tertilt (2009), who dealt with the secular change in the household size. In their model, families are collections of roommates who coreside solely because they can share household public goods. The working mechanism of their model hinges on non-homothetic preferences: when income increases, the relative demand of the public good shrinks, thereby diminishing the incentive to coreside. Our analysis has a different focus, for we are concerned with intergenerational issues and intra-household decisions. In our model, preferences are homothetic and the coresidence decision is affected by the bargaining process between the young and the old.

2 The family structure: benchmark model

The economy is an OLG economy populated by two generations of individuals living for two periods, the young ('y') and the old ('o').[9] There is no intragenerational heterogeneity. The economy produces one good ('Y') using the human capital of the young (H^y) and the human capital of the old (H^o) as inputs. We assume that the two types of human capital are perfect substitutes in the production function[10]

[9] The model presented in this section is a slightly modified version of Kotlikoff and Morris's (1988) model.

[10] This simplifying assumption guarantees that wages in efficiency units are constant and equal for the young and the old. This implies that the relative income of the two

$$Y_t = H_t^y + H_t^o. \tag{1}$$

The human capital of the two generations evolves exogenously according to a law of motion that we shall specify later.[11] The labour supply of each individual is fixed and normalized to 1. The growth rate of the population is 0.

The final good is the numeraire. There is no physical capital and no saving: in each period the young and the old consume all the available income. As a consequence, the choice of an agent in one period only depends on the variables that affect the utility function in that period.[12] In what follows we omit time subscripts for the sake of clarity. The young and the old can either live apart or coreside.

2.1 The utility function

The utility function of an agent of type i is:

$$U(c^i, x^i; \delta) = \alpha \log c^i + (1-\alpha) \log x^i + \delta \log \kappa^i, \tag{2}$$

where $i = y, o$ and c^i is consumption. The variable x^i is a good that can be either bought by both the young and the old on the market, or, in the case of coresidence, can be shared among the members of the family (for instance, housing services). The price of x is denoted by p. We assume that x is produced using a linear technology $x = ZY^x$, where Y^x are the units of the final good Y used in the production of x. In equilibrium, $Z = \frac{1}{p}$.

The parameter δ is a dummy variable. It takes the values $\delta = 0$, if agent i lives alone, and $\delta = 1$ if the agents coreside. The variable κ^i measures the taste for living together. For $\kappa^i = 1$, the individual i draws no direct utility from living together; for $\kappa^i < 1$ agents get a negative direct utility from living in a family, and for $\kappa^i > 1$ they get a positive direct utility. Therefore, living together has two direct effects on the utility of the agents: first, there is an effect (positive or negative) through the taste for coresidence κ^i; second, there is a (positive) effect through the possibility of sharing the good x.

generations coincides with their relative human capital. More in general, the validity of our results rests on the hypothesis that the relative income of the two generations is an increasing function of their relative human capital. Accordingly, our results would hold in a general CES production function, provided that the elasticity of substitution between the human capital of the two generations is greater than 1.

[11] This exogeneity assumption will be removed in Section 4.

[12] This assumption is made for the sake of simplicity, as in Blackburn and Cipriani (2005).

2.2 Optimal choices

2.2.1 Optimal choices in the case of non-coresidence

If the young and the old live apart, each of them maximizes $\hat{U}(c^i, x^i) \equiv U(c^i, x^i; 0)$ subject to

$$px^i + c^i = wH^i. \tag{3}$$

The variable w is the wage in efficiency units. At equilibrium this is equal to the marginal productivity of labour in efficiency units, which in turn is constant and equal to 1.

The optimal choices are characterized by the following equations:

$$\hat{c}^{i*} = \alpha w H^i; \tag{4}$$

$$\hat{x}^{i*} = (1-\alpha)\frac{w}{p}H^i. \tag{5}$$

Thus the indirect utility function is:

$$\hat{V} \equiv \hat{U}(\hat{c}^{i*}, \hat{x}^{i*}) = \alpha \log \alpha w H^i + (1-\alpha)\log\left((1-\alpha)\frac{w}{p}H^i\right). \tag{6}$$

2.2.2 Optimal choices in the case of coresidence

We assume that, in the case of coresidence, the young and the old bargain over the distribution of the resources within the family. We impose the requirement that the bargaining process lead to an efficient solution.

The household maximizes the sum of the utility functions of the young and the old, weighted by their respective bargaining power:

$$\max \theta \tilde{U}(c^y, x) + (1-\theta)\tilde{U}(c^o, x),$$

subject to

$$px + c^y + c^o = wH^y + wH^o, \tag{7}$$

where $\tilde{U}(c^i, x) \equiv U(c^i, x; 1)$. Notice that x appears here as a pure public good.

The optimal choices are:

$$\tilde{c}^{y*} = \theta\alpha(wH^y + wH^o), \tag{8}$$

$$\tilde{c}^{o*} = (1-\theta)\alpha(wH^y + wH^o), \tag{9}$$

$$\tilde{x}^{*} = (1-\alpha)\frac{(wH^y + wH^o)}{p}, \tag{10}$$

and the indirect utility functions are:

$$\begin{aligned}\tilde{V}^y(\theta,\kappa^y) \equiv \tilde{U}(\tilde{c}^{y*},\tilde{x}^*) = \alpha \log \theta\alpha(wH^y + wH^o) + \\ +(1-\alpha)\log(1-\alpha)\frac{(wH^y + wH^o)}{p} + \log \kappa^y,\end{aligned} \tag{11}$$

$$\begin{aligned}\tilde{V}^o(\theta,\kappa^o) \equiv \tilde{U}(\tilde{c}^{y*},\tilde{x}^*) = \alpha \log(1-\theta)\alpha(wH^y + wH^o) + \\ (1-\alpha)\log(1-\alpha)\frac{(wH^y + wH^o)}{p} + \log \kappa^o.\end{aligned} \tag{12}$$

2.2.3 Optimal choice between coresidence and living alone

The solution to this maximization problem gives the allocation of resources within the family for any value of the bargaining power of the young, θ. However, not all values of θ are compatible with the choice of coresidence. In particular, coresidence can only occur when there exists at least one value of θ such that coresidence is attractive to one of the agents, and indifferent to the other. In what follows we will characterize the interval of values of θ that are compatible with the choice of coresidence.[13]

We define θ_{min} as the value of θ such that: $\tilde{V}^y(\theta,\kappa^y) = \hat{V}^y$. By solving the equation, we get

$$\theta_{min} = \left(\frac{H^y}{H^y + H^o}\frac{1}{\kappa^y}\right)^{\frac{1}{\alpha}}. \tag{13}$$

According to this definition, θ_{min} is the value of the bargaining power of the young such that they are indifferent between living alone or with the old. Notice that, according to Equation (11), $\tilde{V}^y(\theta,\kappa^y)$ is increasing in θ. It follows that for any $\theta > \theta_{min}$, the young prefer coresidence. Notice also that a value $0 \leq \theta_{min} \leq 1$ such that $\tilde{V}^y(\theta,\kappa^y) = \hat{V}^y$ exists if and only if

$$\frac{H^y}{H^y + H^o} \leq \kappa^y. \tag{14}$$

If not, the young always decide to live alone. Finally, notice that Condition (14) always holds for any $\kappa^y > 1$.

Similarly, we define θ_{max} as the value of θ such that: $\tilde{V}^o(\theta,\kappa^o) = \hat{V}^o$. By solving the equation we get

$$\theta_{max} = 1 - \left(\frac{H^o}{H^y + H^o}\frac{1}{\kappa^o}\right)^{\frac{1}{\alpha}}, \tag{15}$$

[13] The same procedure was used by Iyigun and Walsh (2007) in the analysis of the bargaining between husbands and wives.

Hence, θ_{max} is the value of the bargaining power of the young such that the old are indifferent between living alone or forming a family with the young. Since $\tilde{V}^o(\theta, \kappa^o)$ is decreasing in θ (Equation (12)), the old prefer coresidence for any $\theta < \theta_{max}$. Notice that the condition $0 \leq \theta_{max} \leq 1$ holds if and only if

$$\frac{H^o}{H^y + H^o} \leq \kappa^o. \tag{16}$$

If not, the old always decide to live alone. Notice also that Condition (16) always holds for any $\kappa^o > 1$.

According to these definitions, we can parametrize the possibility of coresidence to the ratio $\frac{\theta_{min}}{\theta_{max}}$:

- if $\frac{\theta_{min}}{\theta_{max}} < 1$, there exists θ such that coresidence is advantageous for both the young and the old. Living alone is inefficient: the utility levels that can be achieved from living alone are inside the utility possibility set that can be derived from coresidence.

- if $\frac{\theta_{min}}{\theta_{max}} = 1$, both the young and the old are indifferent between coresidence and living alone. The utility levels that can be achieved from living alone are on the frontier of the utility possibility set that can be derived from coresidence.

- if $\frac{\theta_{min}}{\theta_{max}} > 1$, there is no θ such that coresidence is attractive to both the young and the old. The utility levels that can be achieved from living alone are outside the utility possibility set that can be derived from coresidence.

Computing $\frac{\theta_{min}}{\theta_{max}}$ we find:

$$\frac{\theta_{min}}{\theta_{max}} = \frac{\left(\frac{H^y}{H^y+H^o}\frac{1}{\kappa^y}\right)^{\frac{1}{\alpha}}}{1-\left(\frac{H^o}{H^y+H^o}\frac{1}{\kappa^o}\right)^{\frac{1}{\alpha}}} = \frac{\left(\frac{h}{(1+h)\kappa^y}\right)^{\frac{1}{\alpha}}}{1-\left(\frac{1}{(1+h)\kappa^o}\right)^{\frac{1}{\alpha}}}, \tag{17}$$

where $h \equiv \frac{H^y}{H^o}$.

As a consequence, living arrangements will depend on the taste for coresidence κ^i, and on the relative income of the young and the old. We can distinguish four cases.

1. $\kappa^i = 1$ for $i = y, o$. We have $\frac{\theta_{min}}{\theta_{max}} < 1$ provided that $\alpha < 1$. If living together brings no variation to the utility functions of both the young and the old, then living together is always Pareto improving, because of the possibility of sharing the good x. On the other hand if $\alpha = 1$

then $\frac{\theta_{min}}{\theta_{max}} = 1$, and both the young and the old are indifferent between coresidence and living alone.

2. $\kappa^i > 1$ for $i = y, o$. In this case, $\frac{\theta_{min}}{\theta_{max}} < 1$ always holds. This case is trivial, as both the individuals draw utility from living together.

3. $\kappa^i < 1$ for $i = y, o$. In this case, $\frac{\theta_{min}}{\theta_{max}}$ can be $\lesseqgtr 1$ if $\alpha < 1$. When both parties dislike coresidence, the decision to coreside or not depends on the distaste for coresidence and on the relative income. In the limit for $\kappa^i \longrightarrow 0$, $\frac{\theta_{min}}{\theta_{max}} > 1$. If the distaste is maximum for both of them, then coresidence is obviously suboptimal. Living alone is Pareto improving if $\alpha = 1$.

4. $\kappa^y < 1$ and $\kappa^o \geq 1$, or $\kappa^o < 1$ and $\kappa^y \geq 1$. Here the young (or the old) dislike coresidence, but the other party like it. In this case, $\frac{\theta_{min}}{\theta_{max}}$ can be $\lesseqgtr 1$.

In this paper, we assume that agents do not leave the possibility of Pareto improvements unexploited. This means that whenever $\frac{\theta_{min}}{\theta_{max}} < 1$, the actual bargaining power θ always falls within the interval $[\theta_{min}, \theta_{max}]$, and coresidence is chosen. Notice that further specifications of $\theta \in [\theta_{min}, \theta_{max}]$ are not necessary to characterize the coresidence choice. They would instead be necessary if were interested in the allocation of the resources within the family.[14] In that case, it would always be possible to specify $\theta \in [\theta_{min}, \theta_{max}]$ as an exogenous function of θ_{min} and θ_{max}. Therefore, like in the standard collective model,[15] in our model the actual bargaining power would depend on the individual characteristics of the agents. However, differently from the standard collective model, we also require that the actual bargaining power θ is such that the coresidence choice is incentive compatible for both agents: participating to the bargaining process must be Pareto improving.

[14]This will be the case in Section 4, where the allocation of resources within the family influences the accumulation of human capital, in the context of a model with endogenous growth. On the contrary, in Section 3, where exogenous growth is assumed, we will not specify any rule for the actual bargaining power θ.

[15]See Chiappori (1988), Chiappori (1992a), Chiappori (1992b).

3 Economic development and family structure: exogenous growth

In this section, we shall study how technical change affects family structure in an exogenous growth model.

We assume that the human capital of the two generations develops according to the following laws of motion:

$$H_t^y = (1 + g_t)H_{t-1}^y, \tag{18}$$

$$H_t^o = (1 + e_t)H_{t-1}^y, \tag{19}$$

where g is the exogenous growth rate of the young's human capital, and e is an exogenous experience premium of the learning-by-doing type. Our working hypothesis is that technological developments determine g while leaving e unaffected. The idea is that technical progress is age-biased towards the young. This is so for a number of reasons, discussed in a recent widespread literature on vintage capital, technology adoption and diffusion.[16] In a nutshell, the young have more incentive to forego current production to learn the new technology, as their time span is longer, and therefore the discounted reward higher. Moreover, if the technical innovation is a major one, the experience premium of the old quickly gets eroded, and the young, who will probably learn the new technology directly, will end up being more skilled.[17]

The growth rate of this economy, γ, reads

$$1 + \gamma_{t+1} \equiv \frac{Y_{t+1}}{Y_t} = \frac{(1 + g_{t+1}) + (1 + e_{t+1})}{(1 + g_t) + (1 + e_t)}(1 + g_t). \tag{20}$$

Along a balanced growth path, g and e ought to be constant. This implies

$$1 + \gamma = 1 + g, \tag{21}$$

that is, the growth rate of the economy coincides with the growth rate of the human capital of the young.

Using Equations (18) and (19) we obtain

$$h = \frac{1 + g}{1 + e}. \tag{22}$$

[16]See Ahituv and Zeira (2010), Chari and Hopenhayn (1991), Jovanovic and Nyarko (1996).

[17]This will be particularly true if the young have higher general education than the old as opposed to the vocational education of the skill-specific or the learning-by-doing type (Krueger and Kumar (2004)).

Such a formulation makes the relative skills between generations an increasing function of the rate of technical progress and a decreasing function of the experience premium.

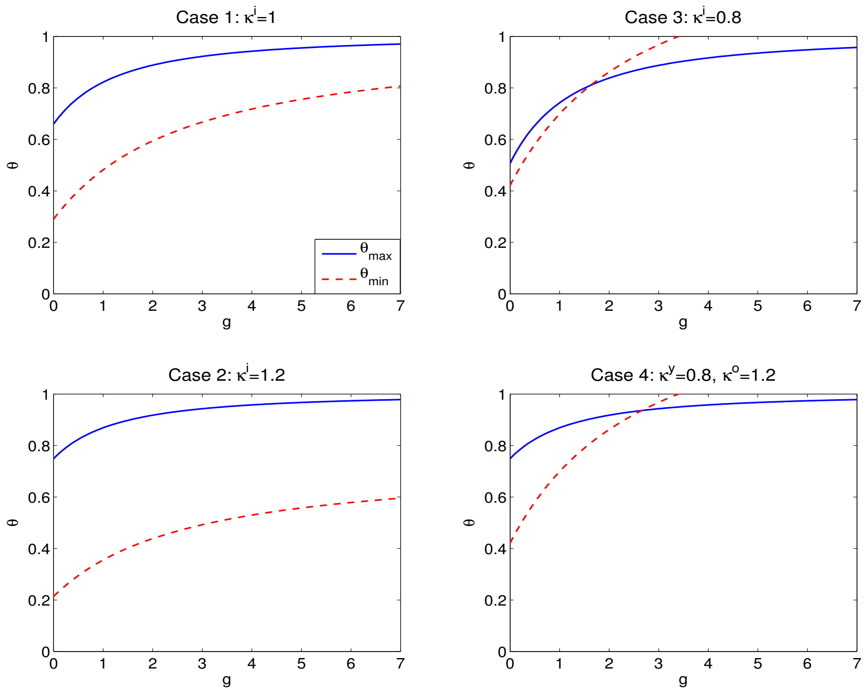

Figure 3: Patterns of θ_{min} and θ_{max} as a function of g for different values of κ^i, with $\alpha = 0.6$ and $e = 0.1$.

To grasp the final effect of technical change on the coresidence pattern, we need to study how g affects the ratio $\frac{\theta_{min}}{\theta_{max}}$. Studying the derivative, we obtain

$$\frac{\partial \frac{\theta_{min}}{\theta_{max}}}{\partial g} = \frac{1}{1+e} \frac{\partial \frac{\theta_{min}}{\theta_{max}}}{\partial h}, \tag{23}$$

where

$$\frac{\partial \frac{\theta_{min}}{\theta_{max}}}{\partial h} = \frac{\left[1-(1+h)\left(\frac{1}{\kappa^o(1+h)}\right)^{\frac{1}{\alpha}}\right]\left(\frac{h}{\kappa^y(1+h)}\right)^{\frac{1}{\alpha}}}{\alpha h(1+h)\left[\left(\frac{1}{\kappa^o(1+h)}\right)^{\frac{1}{\alpha}}-1\right]^2}. \tag{24}$$

The sign of this derivative is positive if and only if $\kappa^o > \left(\frac{1}{1+h}\right)^{1-\alpha}$. A sufficient condition for the latter is $\kappa^o \geq 1$.

This simple model is able to predict the observed shift in intergenerational living arrangements. In the model, such a shift may happen for several reasons: a change in the attitude towards coresidence embedded in the parameters κ^i; a change in the experience premium e; or a change in technology embedded in the parameter g. If for instance κ^i and e are constant and compatible with Cases 3 and 4 in Section 2.2.3, a suitable change in g is sufficient to explain the change in living arrangements, provided that coresidence was the initial state. Notice that in this case, we do not need to refer to any change in preferences to account for the change in living arrangements: economic development suffices.

To illustrate the point, Figure 3 shows the values of θ_{min} and θ_{max} plotted against g. In this numerical example, when g increases enough, living arrangements shift from coresidence to non-coresidence in Cases 3 and 4. In the other cases, coresidence is always optimal.

4 Economic development and family structure: endogenous growth

In the previous section, we studied how economic development affects family structure. There, we assumed exogenous growth, thereby ignoring the feedback effects that the family structure might have on economic development. In this section, we shall remove this assumption and extend the model by introducing endogenous human capital accumulation. This will allow us to explore the bidirectional link between economic development and the family structure.

4.1 The model

Agents live for three periods. In the first period, the agent is a child and makes no active choices. He or she lives with the young and accumulates human capital which is assumed to depend on the parents' choices only.

In the second period, the agent is young and has one child.[18] The utility function is almost identical to that of Section 2. The only difference is that here we assume that parents have a warm-glow motivation for investing

[18] We assume that the growth rate of the population is 0.

in their child's human capital:

$$U^y(c_t^y, x_t^y, H_{t+1}^y; \delta) = \alpha \log c_t^y + \zeta \log x_t^y + (1 - \alpha - \zeta) \log H_{t+1}^y + \delta \log \kappa^y. \quad (25)$$

The young has a time endowment of 1. He or she can either work or invest in the human capital of the child. We call s_t the amount of time the young dedicate to increasing the human capital of the child, according to the production function

$$H_{t+1}^y = \xi s_t H_t^y, \quad (26)$$

where $\xi > 1$ is the productivity of the investment in the human capital of the child.

In the third period, the old has the same preferences as in Section 2, but for a slight change of notation:

$$U^o(c_t^o, x_t^o; \delta) = (1 - \zeta) \log c_t^o + \zeta \log x_t^o + \delta \log \kappa^o. \quad (27)$$

Here we denote the weight given to the public good in the utility function as ζ. As in Section 3, the human capital of the old evolves in time according to Equation (19).

4.2 Optimal choices in the case of non-coresidence

The young maximize $\hat{U}^y(c_t^y, x_t^y, H_{t+1}^y) \equiv U^y(c_t^y, x_t^y, H_{t+1}^y; 0)$ subject to the constraints:

$$H_{t+1}^y = \xi s_t H_t^y, \quad (28)$$

$$c_t^y + p_t x_t^y + s_t w H_t^y = w H_t^y. \quad (29)$$

The optimal choices are:

$$\hat{s}_t = (1 - \alpha - \zeta), \quad (30)$$

$$\hat{c}_t^y = \alpha w H_t^y, \quad (31)$$

$$\hat{x}_t^y = \zeta \frac{w H_t^y}{p_t}. \quad (32)$$

Notice that the investment in schooling is constant in the case of non-coresidence.

As far as the old are concerned, nothing changes compared to Section 2.

4.3 Optimal choices in the case of coresidence

As before, the household maximizes the sum of the utility functions of the young and the old, weighted by their respective bargaining power:

$$\max_{c_t^y, c_t^o, s_t, x_t} \theta \tilde{U}^y(c_t^y, x_t, H_{t+1}^y) + (1-\theta)\tilde{U}^o(c_t^o, x_t) \tag{33}$$

subject to:

$$p_t x_t + c_t^y + c_t^o + s_t w H_t^y = w(H_t^y + H_t^o), \tag{34}$$

$$H_{t+1}^y = \xi s_t H_t^y, \tag{35}$$

where $\tilde{U}^y(c_t^y, x_t, H_{t+1}^y) \equiv U^y(c_t^y, x_t, H_{t+1}^y; 1)$, and $\tilde{U}^o(c_t^o, x_t) \equiv U^o(c_t^o, x_t; 1)$.

The optimal choices are:

$$\tilde{s}_t = \theta(1-\alpha-\zeta)\frac{(H_t^y + H_t^o)}{H_t^y}, \tag{36}$$

$$\tilde{c}_t^y = \theta\alpha w(H_t^y + H_t^o), \tag{37}$$

$$\tilde{c}_t^o = (1-\theta)(1-\zeta)w(H_t^y + H_t^o), \tag{38}$$

$$\tilde{x}_t = \zeta\frac{w(H_t^y + H_t^o)}{p_t}. \tag{39}$$

4.4 Optimal choice between coresidence and living alone

Using the same procedure as in Section 2, we compute the threshold values θ_{min}, θ_{max}, such that, for $\theta_{min} < \theta < \theta_{max}$, coresidence is always Pareto improving:

$$\theta_{min} = \left(\frac{h_t}{1+h_t}\frac{1}{\kappa^y}\right)^{\frac{1}{1-\zeta}}, \tag{40}$$

$$\theta_{max} = 1 - \left(\frac{1}{1+h_t}\frac{1}{\kappa^o}\right)^{\frac{1}{1-\zeta}}. \tag{41}$$

This allows us to parametrize the possibility of coresidence to the ratio $\frac{\theta_{min}}{\theta_{max}}$ again.

4.5 Dynamics

In order to have an analytical solution to the dynamics of the model, we have to assume $\zeta = 0$.[19] This means that we disregard the role of the public good. Furthermore, we shall restrict the analysis to the case $\kappa^y < 1$ and $\kappa^o > 1$.[20] Thus, the incentives for coresidence is reduced to a kind of transfer between the members of the family: the old, who like coresidence, allow the young, who dislike it, to grasp more resources in exchange for coresidence. In a sense, the old buy off the young.

The growth rate of output, γ, is

$$1 + \gamma_t \equiv \frac{Y_t}{Y_{t-1}} = \frac{(1 - s_t)H_t^y + H_t^o}{(1 - s_{t-1})H_{t-1}^y + H_{t-1}^o} = \frac{[(1 - s_t)h_t + 1](1 + e)h_{t-1}}{(1 - s_{t-1})h_{t-1} + 1}. \tag{42}$$

Along a balanced growth path, Equation (42) reduces to

$$1 + \gamma = (1 + e)h. \tag{43}$$

From Equations (19) and (26), we know that

$$h_t = \frac{\xi s_{t-1}}{1 + e}, \tag{44}$$

where we assume that $\forall t,\ e_t = e$.

The relative human capital of the young is now an endogenous variable, and is determined by the amount of time that the young invest in schooling. As s_{t-1} differs depending on whether agents lived together in $t - 1$ or not, the value of of the growth rate along a balanced growth path, γ, depends on the coresidence status. We have two cases. If in $t - 1$ the agents did not live together, then the relevant choice for s is Equation (30). It follows that the value

$$h_t = \frac{\xi(1 - \alpha)}{1 + e} \equiv h^{nc} \tag{45}$$

does not depend on time. That is, in the non-coresidence case, the relative human capital is always constant and equal to its balanced growth path level h^{nc}.

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[19] The primary focus of this article is the role played by technical progress and cultural factors in determining the coresidence choice. Accordingly, overlooking the role of the public good is not a major limitation of the scope of the analysis. For a complementary study more focused on the role of the public good in influencing the coresidence decision see Salcedo, Schoellman, and Tertilt (2009).

[20] As shown in the Appendix, the assumption $\kappa^o > 1$ is necessary to achieve a sustainable intertemporal equilibrium. Consequently, we also assume $\kappa^y < 1$ so as to have the possibility of a shift between coresidence and non-coresidence, as explained in Section 2.2.3.

If the agents lived together in $t-1$, then the relevant choice for s is Equation (36). It follows that Equation (44) now reads:

$$h_t = \theta_{t-1} \frac{\xi(1-\alpha)}{1+e} \frac{1+h_{t-1}}{h_{t-1}}. \tag{46}$$

In this paper, we assume that agents do not leave the possibility of Pareto improvements unexploited. This means that whenever $\frac{\theta_{min}}{\theta_{max}} < 1$, the actual θ always falls within the interval $[\theta_{min}, \theta_{max}]$, and coresidence is chosen. To be more specific, we shall assume below that

$$\theta = \lambda\theta_{min} + (1-\lambda)\theta_{max}, \tag{47}$$

with $0 < \lambda < 1$ standing for exogenous factors affecting the outcome of the bargaining process (for instance, the individual ability to bargain).

Substituting for θ in Equation (46), we have

$$h_t = \frac{\xi(1-\alpha)}{1+e} \left(\frac{\lambda}{\kappa^y} + \frac{1-\lambda}{\kappa^o} \frac{\kappa^o(1+h_{t-1})-1}{h_{t-1}} \right). \tag{48}$$

The balanced-growth-path solution of Equation (48) reads

$$\begin{aligned} h^c = {} & \frac{(1-\alpha)\kappa^o[\kappa^y(1-\lambda)+\lambda)]\xi}{2(1+e)\kappa^y\kappa^o} + \\ & + \frac{\sqrt{(1-\alpha)\kappa^o\xi[4(1+e)(\kappa^o-1)\kappa^{y2}(1-\lambda)+(\xi(1-\alpha)\kappa^o(\kappa^y(1-\lambda)+\lambda)^2)]}}{2(1+e)\kappa^y\kappa^o}. \end{aligned} \tag{49}$$

The overall dynamics of this model is non-trivial. We have two dynamic rules and two balanced growth paths, depending on whether the agents do or do not coreside. Moreover, there is, in principle, room for switching from one equilibrium to the other. Switching occurs whenever the ratio $\frac{\theta_{min}}{\theta_{max}}$ goes from less than one to more than one, or vice versa.

The following proposition characterizes completely the dynamics.

Proposition 1
Given

$$\xi_1 \equiv \frac{\kappa^y(\kappa^o-1)}{\kappa^o(1-\kappa^y)} \frac{(1+e)}{(1-\alpha)}, \tag{50}$$

$$\xi_2 \equiv \kappa^y \xi_1. \tag{51}$$

(i) $\forall\ \xi > \xi_1$, the economy converges towards h^{nc}. Non-coresidence is the chosen living arrangement along the balanced growth path.

(ii) $\forall\ \xi < \xi_2$, *the economy converges towards* h^c. Coresidence is the chosen living arrangement along the balanced growth path.

(iii) $\forall\ \xi_2 < \xi < \xi_1$, *there is no stable balanced growth path.* The economy oscillates perpetually between coresidence and non-coresidence.

Proof
See Appendix. ■

4.6 Comparative statics

In this section, we discuss the effects of variations in the parameters of the model economy on living arrangements, on economic growth, and on (a suitable definition of) the social status of the two generations.[21]

4.6.1 Family structure and economic growth

We start by studying the effects of a change in ξ on the family structure. First we notice that $\xi > 1$ plays the same role as $(1 + g)$ in Section 3. Accordingly, it can be interpreted as age-biased technical change.

The main effects that changes in ξ have on the family structure have already been spelt out in Proposition 1. *Ceteris paribus*, and in particular given the taste for coresidence κ^i, an increase in ξ makes coresidence less likely to appear as a stable equilibrium. It follows that in this model, a suitable increase in technical progress is enough to account for a shift in the living arrangements, from coresidence to non-coresidence.

On the other hand, Proposition 2 below shows that suitable changes in the cultural factors κ^y and κ^o lead to the same result.

Proposition 2

(i) $\frac{\partial \xi_1}{\partial \lambda} = \frac{\partial \xi_2}{\partial \lambda} = 0$.

(ii) $\frac{\partial \xi_2}{\partial \kappa^y} > \frac{\partial \xi_1}{\partial \kappa^y} > 0$.

(iii) $\frac{\partial \xi_1}{\partial \kappa^o} > \frac{\partial \xi_2}{\partial \kappa^o} > 0$.

[21] Notice that in the model there is also room for endogenous changes in the living arrangements. Take for instance point *(i)* in Proposition 1. For any initial level of $h_0 < \hat{h}$, the economy starts in coresidence, but the dynamics of the model is such that the economy converges towards the non-coresidence steady state h^{nc} (see Figure 5 in the Appendix).

Proof
(i), *(ii)* and *(iii)* follow immediately from the computation of the derivatives of Equations (50) and (51). ■

Changes in λ stands for changes in unspecified idiosyncratic factors affecting the actual bargaining power of the young, θ. The higher is λ, the lower is θ. Changes in λ do not produce any shift in living arrangements.

When κ^y decreases, the threshold values ξ_2 and ξ_1 decrease: thus for a given value of ξ, non-coresidence is more likely to appear as a stable living arrangement. Moreover, since ξ_2 decreases more than ξ_1, the region of values of ξ for which a balanced growth path does not exist becomes larger.

By the same token, when κ^o decreases, non-coresidence is more likely to appear as a stable living arrangement. At the same time, the region of values of ξ for which a balanced growth path does not exist shrinks.

So, according to our model there are two possible explanations for the change in the living arrangement from coresidence to non-coresidence that is observed across countries and through time. One relies on economic factors - technical change. The other relies on cultural factors - change in the taste for coresidence. In Proposition 3, we shall spell out the implications of the two explanations on economic growth.

We can define $\gamma^{nc}(\xi, \kappa^y, \kappa^o, \lambda)$ as the growth rate of output along a balanced growth path when non-coresidence is the stable living arrangement. Analogously, we define $\gamma^{c}(\xi, \kappa^y, \kappa^o, \lambda)$ as the growth rate of output along a balanced growth path when coresidence is the stable living arrangement. Proposition 3 shows how changes in the structural parameters of the model affect the growth rate of the economy. We shall distinguish two cases. First, in points *(i)* and *(ii)* we study the effect of marginal changes in the parameters, such that there is no shift in the chosen living arrangement. Second, in point *(iii)* we study the situation where the change in the parameters produces a shift in the living arrangement.

Proposition 3
(i) $\forall \xi < \xi_2$ *(coresidence is the stable equilibrium):*

1. $\frac{\partial \gamma^c(\xi,\kappa^y,\kappa^o,\lambda)}{\partial \xi} > 0$. The growth rate of the economy increases with technical change.

2. $\frac{\partial \gamma^c(\xi,\kappa^y,\kappa^o,\lambda)}{\partial \kappa^y} < 0$. The growth rate of the economy decreases if the young likes coresidence more.

3. $\frac{\partial \gamma^c(\xi,\kappa^y,\kappa^o,\lambda)}{\partial \kappa^o} > 0$. The growth rate of the economy increases if the old likes coresidence more.

4. $\frac{\partial \gamma^{c}(\xi,\kappa^{y},\kappa^{o},\lambda)}{\partial \lambda} < 0$. The growth rate of the economy decreases if the actual bargaining power of the young decreases.

(ii) $\forall \xi > \xi_1$ (non-coresidence is the stable equilibrium):

1. $\frac{\partial \gamma^{nc}(\xi,\kappa^{y},\kappa^{o},\lambda)}{\partial \xi} > 0$. The growth rate of the economy increases with technical change.

2. $\frac{\partial \gamma^{nc}(\xi,\kappa^{y},\kappa^{o},\lambda)}{\partial \kappa^{y}} = 0$. The growth rate of the economy is not affected by changes in the young's taste for coresidence.

3. $\frac{\partial \gamma^{nc}(\xi,\kappa^{y},\kappa^{o},\lambda)}{\partial \kappa^{o}} = 0$. The growth rate of the economy is not affected by changes in the old's taste for coresidence.

4. $\frac{\partial \gamma^{nc}(\xi,\kappa^{y},\kappa^{o},\lambda)}{\partial \lambda} = 0$. The growth rate of the economy is not affected by changes in the young's actual bargaining power.

(iii) Shift from coresidence to non-coresidence:

1. *Following a change in ξ from $\xi < \xi_2$ to $\xi' > \xi_1$, $\Rightarrow \gamma^{nc}(\xi', \kappa^{y}, \kappa^{o}, \lambda) > \gamma^{c}(\xi, \kappa^{y}, \kappa^{o}, \lambda)$.* When the shift in living arrangements is induced by an increase in technical change, the resulting growth rate of the economy is higher.

2. *Following a change in κ^{y} from κ^{y} to $\kappa^{y\prime} < \kappa^{y}$ such the economy shifts from $\xi < \xi_2 < \xi_1$ to $\xi > \xi_1' > \xi_2'$, $\Rightarrow \gamma^{nc}(\xi, \kappa^{y\prime}, \kappa^{o}, \lambda) < \gamma^{c}(\xi, \kappa^{y}, \kappa^{o}, \lambda)$.* When the shift in living arrangements is induced by a decrease in the young's taste for coresidence, the resulting growth rate of the economy is lower.

3. *Following a change in κ^{o} from κ^{o} to $\kappa^{o\prime} < \kappa^{o}$ such the economy shifts from $\xi < \xi_2 < \xi_1$ to $\xi > \xi_1' > \xi_2'$, $\Rightarrow \gamma^{nc}(\xi, \kappa^{y}, \kappa^{o\prime}, \lambda) < \gamma^{c}(\xi, \kappa^{y}, \kappa^{o}, \lambda)$.* When the shift in living arrangements is induced by a decrease in the old's taste for coresidence, the resulting growth rate of the economy is lower.

Proof
See Appendix. ■

The analysis developed so far leads to the conclusion that, following an increase in ξ (economic factors), economic growth and independent living can be positively correlated. On the other hand, a decrease in κ^{i} (cultural factors) can account for the observed shift from coresidence to non-coresidence only at the price of reducing economic growth.[22] As shown in Figure 2, there exist a negative correlation between the growth rate of GDP and the coresidence rate in the United States. Reading this finding through the lens of our theory, we can claim that the economic factors are the major determinant of the observed shift in intergenerational living arrangements.

Our theory in also consistent with the observation that in some developing countries, say India, high growth rates of GDP per capita go along with a coresidence rate higher than that of developed countries, say the United States, with lower growth rates of GDP per capita.[23] In facts, as stated in Proposition 2, different cultural aptitudes towards coresidence cause the same rate of technical progress to have different effects on the coresidence patterns. In particular, when there is a strong positive taste for coresidence, extremely high rates of technical progress might be required to cause a shift in living arrangements. In terms of our model, when κ^i is high, the threshold values ξ_2 and ξ_1 are high: thus high values of ξ are needed to generate non-coresidence as a stable living arrangement.

4.6.2 The decline of the *pater familias*

So far, we have discussed how the structural parameters of the model affect the coresidence pattern and the growth of the economy. We now turn to the variations in the social status of the two generations. As we mentioned in the Introduction, there is evidence in sociology of a co-movement between the social status of the elderly and changes in the living arrangements of the family. From an economist's point of view, however, the concept of 'social status' is rather elusive. Below, we use a narrow definition of social status. We define the social status of each generation i as the share of total resources allocated to it, $\frac{H^i}{H^y+H^o}$. In the case of coresidence, that is for $\xi < \xi_2$,

[22]It is straightforward to verify that increases in the experience premium e raise the threshold values ξ_1 and ξ_2, and reduce the balanced-growth-path values h^{nc} and h^c. It follows that coresidence is more likely to appear for a given ξ, as e rises. As to the rate of growth of the economy, the effects on γ of variations in e pass through the bargaining power. Consequently, variations in the experience premium have no effect on the rate of growth of the economy if the young and the old live apart. If they live together, higher values of e are associated with lower values of h^c: as the old have more bargaining power, the young will invest less in schooling.

[23]In 2000, the growth rate of GDP per capita in the United States was 2.5% and the percentage of persons aged 60+ living alone was 25.9%. In 1998, the growth rate of GDP per capita in the India was 6.5% and the percentage of persons aged 60+ living alone was 3.3%. Data for living arrangements are from United Nations (2005). Data about GDP per capita are from Maddison (2011).

the social status of the young so defined coincides with the bargaining power θ, while $(1-\theta)$ is the social status of the old. When non-coresidence is the equilibrium, that is for $\xi > \xi_1$, along a balanced growth path the social status of the young rewritten in terms of h is $\frac{h^{nc}}{1+h^{nc}}$, while that of the old is $1 - \frac{h^{nc}}{1+h^{nc}}$.

We are now going to study under what conditions the social status of the old, as defined here above, deteriorates when the economy shifts from coresidence to non-coresidence. The aim is to verify whether our model is compatible with the sociological literature mentioned above.[24]

Proposition 4
Given

$$\epsilon = \frac{\kappa^o}{\kappa^y} > 1.$$

If the economy shifts from coresidence to non-coresidence, following a change in ξ from $\xi < \xi_2$ to $\xi' > \xi_1\epsilon$, then, the social status of the old implied by ξ, $1-\theta$, is greater than the social status of the old implied by ξ', $1 - \frac{h^{nc}}{1+h^{nc}}$.

Proof
See Appendix. ■

This proposition shows that, if technical change is big enough, shifts from coresidence to non-coresidence are accompanied by a deterioration in the social status of the elderly. In particular, the technical change needed to induce such a deterioration depends on the cultural factors κ^o and κ^y, and is in any case greater than the technical change needed to induce the transition from coresidence to non-coresidence.[25] The rationale for this result is that the higher the ratio κ^o/κ^y, the lower the value of the social status of the elderly in the case of coresidence, $1-\theta$: when, relative to the young, the old like coresidence a lot, they are more ready to give up resources to the young to keep them within the family.

We can conclude by saying that, on top of being able to discriminate between the economic and the cultural explanations of the observed change in living arrangements, the model presented in this article is also consistent with the progressive diminution of the social status of the elderly stressed by the sociological literature mentioned in the Introduction.

[24]We limit our analysis to the case in which the shift from coresidence to non-coresidence is due to technical change.

[25]Remember that we have assumed $\kappa^o > 1$ and $\kappa^y < 1$.

5 Conclusions

In this article, we have provided a unified framework accounting qualitatively for the shift in intergenerational living arrangements from coresidence to non-coresidence, economic growth, and the diminution in the status of the elderly documented by the literature.

We used a dynamic general equilibrium model of coresidence, where the decisional set-up of the household is modeled using a collective model of bargaining. The results show that, when technical progress is fast enough, the economy experiences a shift from stagnation to growth, there is a transition from coresidence to non-coresidence, and the social status of the elderly tends to deteriorate. Moreover, when the shift in living arrangements is explained by technical change (economic factors), the model economy experiences an increase in the growth rate along a balanced growth path. On the contrary, when the shift in living arrangements is explained by changes in the taste for coresidence (cultural factors), the model economy experiences a reduction in the growth rate along a balanced growth path. Given that the empirical evidence on the United States shows a negative correlation between the growth rate of GDP and the coresidence rate, our analysis implies that economic factors must have played a major role in explaining the historical shift from coresidence to non-coresidence.

This article is a first step towards a general theory of the interaction between economic development and intergenerational living arrangements. The mechanism explored here hinges on age-biased technical change as the key factor behind the change in the relative income of the young. Other mechanisms might have influenced the relative income of the young, for instance the structural change from agriculture to industry during the industrial revolution, the demographic transition, or the emergence of the welfare state. The exploration of those mechanisms, along with a quantitative assessment of their relative importance, is currently on our research agenda.

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Appendix

Balanced-growth-path solution to Equation (48)

In this section we prove that Equation (49) is the balanced-growth-path solution to Equation (48). We also prove that such a solution is locally stable.

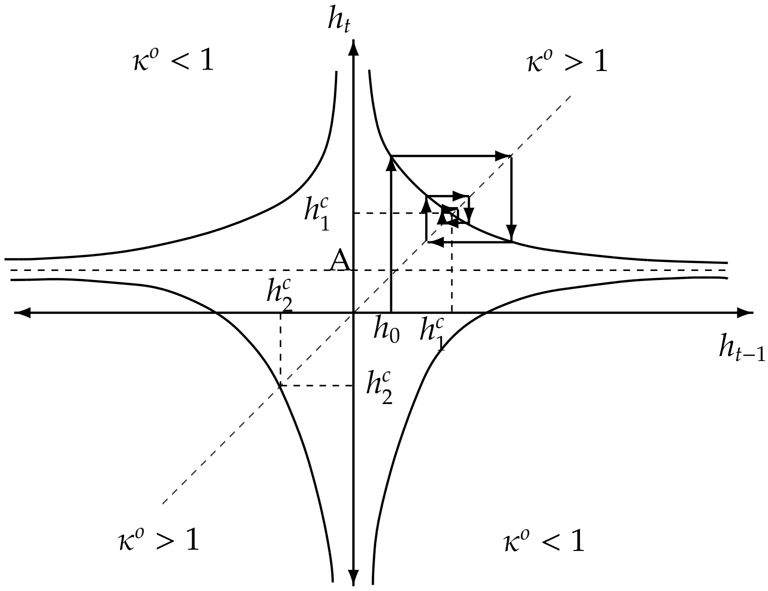

Figure 4: The dynamics for coresidence. $A = \frac{\xi(\alpha-1)(\kappa^y(\lambda-1)-\lambda)}{(1+e)\kappa^y}$

Figure 4 shows the geometrical representation of Equation (48). We restrict the parameters values to $\kappa^o > 1$, which limits the domain of the function to the first and third quadrant. We do so because for $\kappa^o < 1$, the dynamics delivers negative values of h, as can be easily deduced from the graph. This means that for $\kappa^o < 1$ there is no sustainable intertemporal equilibrium.

Equation (48) is a first-order difference equation, that gives us two values for the balanced growth path, that we will label h_1^c and h_2^c. As evident from the graph, $h_2^c < 0$. This implies that only one of the two steady states, namely $h_1^c > 0$, is economically significant. The positive root of Equation (48) is Equation (49).

For h^c to be a locally stable equilibrium, it must be that the slope of the hyperbola crossing the 45 line in h^c has an absolute value less than one. Doing the computations, this turns out to be the case. It follows that h^c is a locally stable equilibrium. Convergence occurs along a cobweb pattern.

Starting in $t = 0$ at a very low level of h_0, the relative human capital in period 1, h_1, will be very high. In period 2, h_2 will again be low, yet greater than h_0. By the same token, h_3 will be high but lower than h_1 and so on. The reverse pattern occurs if the initial value of h is high. In either case the cyclical dynamics converges to h^c.

The rationale behind this cyclical behaviour is that for $h = h_0$, the relative human capital of the young is low. Hence, the opportunity cost $w_0 H_0^y$ of investing in schooling is low compared to the income enjoyed by the young in coresidence, $\theta_0 w_0 (H_0^y + H_0^o)$ (see Equation (36)). As a consequence, investment in schooling will be high, implying $h_1 > h_0$ (see Equation(44)). By the same token, for $h = h_1$, the relative human capital of the young is high, resulting in lower investment in schooling. Notice that in period 2 the economy does not go back to h_0 but it stops at $h_2 > h_0$. The reason is that the actual bargaining power of the young θ is increasing in h, meaning that $\theta_1 > \theta_0$. This means that in period 1 the young are able to capture a larger share of the family income. As schooling is a normal good, this income effect partially offsets the increase in the opportunity cost.[26]

Proof of Proposition 1

First, notice that a comparison between h^{nc} and h^c (the value of human capital along a balanced growth path in the case of non-coresidence and coresidence, respectively) reveals that, *ceteris paribus*, $h^c > h^{nc}$.[27] The rationale for this result lies in the way in which we have formulated the problem. By assuming $\zeta = 0$, we have eliminated the public good from the utility function. This implies that the only rationale for coresidence in this model is a greater availability of resources. In other words, young people in this model do coreside if by doing so they get more resources. As a constant share of these resources are dedicated to the education of the offspring, it follows that the relative human capital of the young ought to be higher in the case of coresidence.

To prove the result analytically, notice that using equations (45) and (49),

[26] The presence of coresidence cycles is robust to alternative specifications of the human capital production function (Equation (26)). In particular, it is possible to show that cycles also appear when $H_{t+1}^y = \xi s_t^\beta (H_t^y)^{1-\beta}$. In this case, the variable s would stand for resources invested in education, rather than time. Details are available upon request.

[27] Notice that this result does not contradict Proposition 3, as here the comparison is taken for a given ξ.

$$h^c > h^{nc} \Leftrightarrow \frac{(1-\lambda)(\kappa^o - 1)}{\kappa^o} > -\frac{\xi(1-\alpha)}{1+e}\frac{\lambda(1-\kappa^y)}{\kappa^y}. \tag{52}$$

Since we assumed $\kappa^y < 1$ and $\kappa^o > 1$, the Inequality (52) holds $\forall \lambda \in [0,1]$.

Second, given that living arrangements depends on the ratio $\frac{\theta_{min}}{\theta_{max}}$, let us define the threshold level $\hat{h}$ such that $\frac{\theta_{min}}{\theta_{max}} = 1$. That is,

$$\frac{\theta_{min}}{\theta_{max}} = \frac{\left(\frac{h}{(1+h)\kappa^y}\right)}{1 - \left(\frac{1}{(1+h)\kappa^o}\right)} = 1 \;\Rightarrow \hat{h} = \frac{\kappa^y(\kappa^o - 1)}{\kappa^o(1-\kappa^y)}. \tag{53}$$

For any $h_t > \hat{h}$, people do not coreside, and the relevant dynamics is that of Equation (45). For any $h_t < \hat{h}$, people coreside, and the relevant dynamics is that of Equation (48). As we shall make clear below, the dynamics of the model depends on the relative magnitude of $\hat{h}$, h^{nc} and h^c.

Proof of (i)

The value $\xi_1 \equiv \frac{\kappa^y(\kappa^o-1)}{\kappa^o(1-\kappa^y)}\frac{(1+e)}{1-\alpha}$ is the value of ξ such that $h^{nc} = \hat{h}$. We know that $h^c > h^{nc}$. From Equations (45), (49) and (53), we can deduce that both h^c and h^{nc} increase with ξ, while $\hat{h}$ is invariant with respect to ξ. Therefore, $\forall\ \xi > \xi_1 \Rightarrow \hat{h} < h^{nc} < h^c$.

Figure 5 depicts the dynamics of this case. It represents the first quadrant of Figure 4, to which the line for Equation (45) has been added to represent the dynamics for non-coresidence. The arrows shows the direction of the global dynamics.

Let us assume that in period 0, $h_0 < \hat{h}$. The relevant dynamics is that of the coresidence case, i.e. the hyperbola. The relative human capital in period 1 will therefore be h_1. Now, as $h_1 > \hat{h}$, the relevant dynamics becomes that of the non-coresidence case, i.e. the parallel line to the abscissas going through h^{nc}. The relative human capital in period 2 will be h_2. Now, as $h_2 = h^{nc} > \hat{h}$, the economy will remain in h^{nc} for the following periods.

It is straightforward to show that, if $h_0 > \hat{h}$, the economy will converge to h^{nc} in the first period.

Proof of (ii)

The value of $\xi_2 \equiv \frac{(1+e)(\kappa^o-1)(\kappa^y)^2}{(\alpha-1)\kappa^o(\kappa^y-1)} = \kappa^y\xi_1$ is the value of ξ such that $h^c = \hat{h}$. By the same argument used in the Proof of (i), $\forall\ \xi < \xi_2 \Rightarrow h^{nc} < h^c < \hat{h}$.

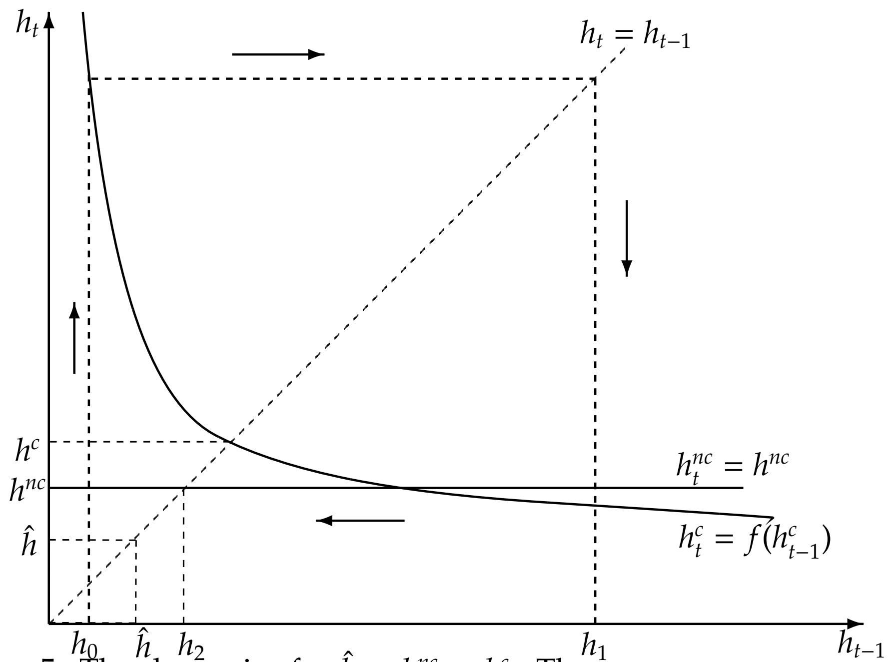

Figure 5: The dynamics for $\hat{h} < h^{nc} < h^c$. The economy converges to h^{nc}: non-coresidence is a globally stable equilibrium.

Figure 6 shows the overall dynamics for this case. Starting from $h_0 < \hat{h}$, the relevant dynamics is initially that of coresidence (the hyperbola). The relative human capital in period 1 will be h_1. As $h_1 > \hat{h}$, the relevant dynamics for the second period becomes that of non-coresidence (the line). The relative human capital in period 2 will be h_2. Now, as $h_2 < \hat{h}$, the relevant dynamics will be again that of coresidence. The relative human capital in period 3 will be $h_3 < \hat{h}$. Henceforth, coresidence will always be chosen, until the stable equilibrium h^c is reached.

The result would be unaltered if we started from $h_0 > \hat{h}$. To verify this claim, it is sufficient to start the reasoning from h_1 in Figure 6.

Proof of (iii)

From the Proof of (i) and (ii), it follows that $\forall\ \xi_2 < \xi < \xi_1 \Rightarrow h^{nc} < \hat{h} < h^c$

Figure 7 shows the dynamics for this case. Starting from $h_0 < \hat{h}$, the relevant dynamics is initially the hyperbola (coresidence). The relative human capital in period 1 will be h_1. Because $h_1 > \hat{h}$, the relevant dynamics now becomes the line (non-coresidence). The relative human capital in period 2 will be h_2. As $h_2 < \hat{h}$, the relevant dynamics in period 2 is again

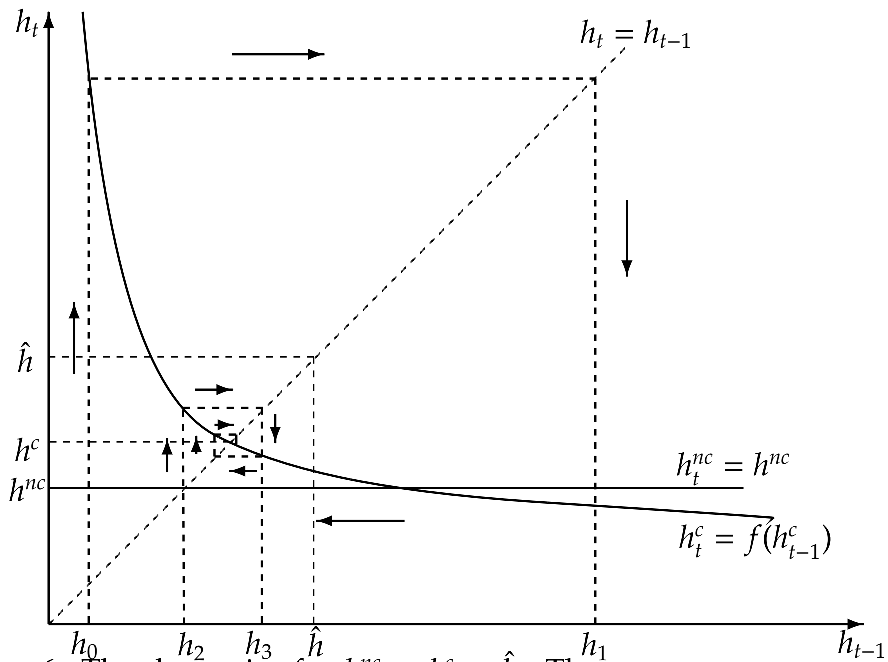

Figure 6: The dynamics for $h^{nc} < h^c < \hat{h}$. The economy converges to h^c: coresidence is a globally stable equilibrium.

the hyperbola (coresidence), meaning that the economy will move from h_2 to h_3. As $h_3 > \hat{h}$, the relevant dynamics is the line (non-coresidence), meaning that the economy will move to $h_4 = h_2$. But then, by the same argument, $h_5 = h_3$, and so on and so forth. This means that the economy will oscillate perpetually between h_2 and h_3, switching from coresidence to non-coresidence in successive periods. As before, the result does not depend on the value of h_0.

Proof of Proposition 3

Equation (43) shows that gamma depends positively on h. So, we shall look at the effects of variations in ξ and κ^i on h. Computing the derivatives of Equations (53), (45) and (49), we get the following results: $\frac{\partial \hat{h}}{\partial \xi} = 0$, $\frac{\partial h^{nc}}{\partial \xi} > 0$, $\frac{\partial h^c}{\partial \xi} > 0$, $\frac{\partial \hat{h}}{\partial \kappa^y} > 0$, $\frac{\partial h^{nc}}{\partial \kappa^y} = 0$, $\frac{\partial h^c}{\partial \kappa^y} < 0$, $\frac{\partial \hat{h}}{\partial \kappa^o} > 0$, $\frac{\partial h^{nc}}{\partial \kappa^o} = 0$, $\frac{\partial h^c}{\partial \kappa^o} > 0$. Points *(i)* and *(ii)* follow immediately. To prove point (*iii.1*), notice that if the return from human capital investment increases from a value ξ below ξ_2 to a value ξ' above ξ_1, living arrangements move from coresidence (with $h^{nc} < h^c < \hat{h}$) to independent living (with $\hat{h} < h^{nc'} < h^{c'}$). Since $h^c < \hat{h} < h^{nc'}$, h increases and so does the balanced growth rate. To prove points (*iii.2*) and (*iii.3*), notice

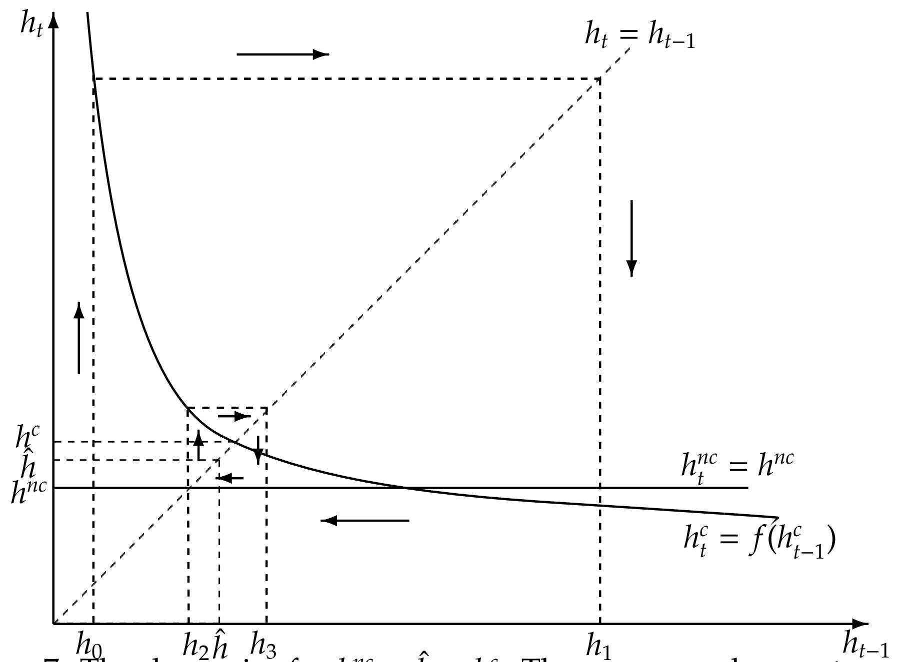

Figure 7: The dynamics for $h^{nc} < \hat{h} < h^c$. The economy does not converge to any stable equilibrium and shows coresidence cycles.

that if κ^i shrinks in such a way that it determines a shift from coresidence (with $h^{nc} < h^c < \hat{h}$) to independent living (with $\hat{h}' < h^{nc} < h^{c'}$), we are sure that the growth rate decreases, since h^{nc} is lower than h^c.

Proof of Proposition 4

In comparing two equilibria, one with coresidence and one with non-coresidence, we assume that the shift from one equilibrium to the other is caused by a change from $\xi < \xi_2$ to $\xi' > \xi_1$.

The minimum value of the social status that the old can enjoy in coresidence is $1 - \theta_{max}$. Using Equation (41) for $h = h^c$ and Equation (49) for $\lambda = 1$, it turns out that $1 - \theta_{max}$ is decreasing in ξ. Evaluating $1 - \theta_{max}$ for $\xi = \xi_2$, which is the highest value of ξ compatible with coresidence, gives

$$1 - \theta_{max} = \frac{1 - \kappa^y}{\kappa^o - \kappa^y}. \tag{54}$$

If we can prove that the transition to non-coresidence implies a social status of the elderly lower than that in Equation (54) then the argument holds true for any $\theta \in [\theta_{min}, \theta_{max}]$.

On the balanced growth path, we can write the social status of the old living alone as

$$1 - \frac{h^{nc}}{1 + h^{nc}} = 1 - \frac{\xi'(1-\alpha)}{(1+e) + \xi'(1-\alpha)} \tag{55}$$

(see Equation (45)). Notice that this expression is decreasing in ξ'. We are looking for the minimum value of ξ' such that the transition from coresidence to non-coresidence implies a diminution in the social status of the elderly. For this purpose, we evaluate Equation (55) for $\xi' = \xi_1 \epsilon$. Then, we compare it to Equation (54). This allows us to single out the minimum value of ϵ such that $1 - \theta_{max} > 1 - \frac{h^{nc}}{1+h^{nc}}$. It turns out that this inequality holds for any $\epsilon > \frac{\kappa^o}{\kappa^y}$.