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Effects of Aspirations and Habits on the Distribution of Wealth*

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Abstract

We analyze how the introduction of habits and aspirations affects the distribution of wealth when the labor productivity of individuals is subject to idiosyncratic shocks and when bequests arise from a joy-of-giving motive. In the presence of either bequests or aspirations, labor income shocks are transmitted intergenerationally, and this transmission, together with contemporaneous shocks, determines the distribution of wealth. We show that the introduction of aspirations (habits) decreases (increases) the average wealth, and increases (decreases) both its intragenerational variability and the degree of intergenerational mobility. Therefore, a distinction between aspirations and habits is relevant because they involve different implications for the distribution of wealth.

Keywords: Bequests; mobility; variability

JEL classification: *D*31; *E*21; *E*62

I. Introduction

In this paper, we analyze how the introduction of aspirations and habits affects the distribution of wealth. When aspirations are present, an individual's utility depends on a comparison between his current consumption and that of his parents. However, in the case of habits, the utility associated with a given amount of current consumption depends on a comparison between an individual's current and past experiences of consumption. So, on the one hand, aspirations generate preferences depending on the previous generation's consumption, while on the other hand, habits are an intragenerational phenomenon, which leads to greater consumption smoothing throughout the life cycle. In both cases, past consumption is used as a

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reference, with which current consumption is compared, and this implies that preferences turn out to be non-time-separable. However, as we will see, the implications for the distribution of wealth are quite different, depending on whether habit or aspiration motivations are more relevant in the evaluation of the utility delivered by current consumption.

A large number of empirical studies provide evidence for the effect of the level of past consumption on the satisfaction derived from current consumption. In accordance with this evidence, some authors have used preferences displaying habit formation to improve the predictions made under time-separable preferences in different economic scenarios.[1] Moreover, there is also empirical evidence for the existence of aspirations associated with the involuntary transmission of tastes from one generation to the next. For instance, Cox *et al.* (2004) estimate that parental preferences explain between 5 and 10 percent of their children's preferences after controlling for their respective incomes.[2]

Our analysis is conducted in the framework of an overlapping generations (OLG) economy where individuals' preferences display "joy of giving". This means that individuals' utility is an increasing function of the amount that they bequeath to their children, as in Yaari (1965) and Abel (1986). Several alternative motives for intergenerational transfers have been proposed in the literature. Among these, we could mention strategic behavior (Bernheim *et al.*, 1985), the existence of incomplete annuity markets (Abel, 1985), and pure intergenerational altruism (Barro, 1974). However, the empirical evidence is not conclusive regarding the reasons why individuals make intergenerational transfers, and a combination of all these motives probably lies at the core of the mechanism governing the intergenerational transmission of wealth.

When individuals care about their children's total income, bequests play an equalizing role because individuals then tend to compensate for the differences in the idiosyncratic realizations of the random income of their direct descendants. This compensation principle has been used to argue against inheritance taxation, because it could have a disequalizing effect as a result of the distortion of the optimal risk sharing between two consecutive generations (Becker and Tomes, 1979; Davies, 1986). This compensation principle does not appear in our framework with joy-of-giving preferences, because individuals do not seek an optimal allocation of family

[1] See, among others, Abel (1990, 1999), Ljungqvist and Uhlig (2000), Carroll *et al.* (1997, 2000), and Alonso-Carrera *et al.* (2004, 2005).

[2] Cavalli-Sforza and Feldman (1981) and Boyd and Richerson (1985) provide surveys of the evidence on intergenerational transmission of tastes. Among the theoretical studies on the macroeconomic implications of aspirations, we could mention those by de la Croix (1996, 2001), de la Croix and Michel (1999, 2001), and Alonso-Carrera *et al.* (2007).

income between themselves and their children, but rather an optimal allocation of individual income between their own consumption and bequests. Bossmann *et al.* (2007) have shown that under joy-of-giving preferences, the introduction of bequests results in a reduction in the value of the coefficient of intragenerational variation of wealth. This is because the average stock of capital grows as a result of the increase in saving induced by the bequest motive, which offsets the modest increase in the variance of wealth associated with the intergenerational transmission of income shocks through bequests.

Our framework will also be suitable for the study of intergenerational mobility, which is characterized by the correlation between the wealth of parents and their children. Obviously, the introduction of bequests has a negative effect on mobility because bequests facilitate the intergenerational transmission of wealth status.

We show that habits and aspirations affect both the size of aggregate bequests and the level of the capital stock in the economy in a similar direction to that obtained by de la Croix and Michel (2001), Jellal and Wolff (2002), and Alonso-Carrera *et al.* (2007), who conducted the analysis under the assumption of altruistic preferences in the same way as Barro (1974). Using the coefficient of variation of wealth as a measure of intragenerational wealth inequality, we also show that the introduction of aspirations increases wealth inequality because aspirations make the shocks in labor income more persistent. This is because aspirations make an individual's adult consumption (and saving) more dependent on the income shocks of his family predecessors, which results in a stronger propagation of these shocks within a dynasty. However, the introduction of habits decreases the intragenerational inequality of wealth when aspirations are present. Even if saving becomes more sensitive to labor income shocks as a result of the stronger desire for consumption smoothing brought about by habits, the increase in the average amount of saving results in a smaller value of the coefficient of variation of saving.

Note that an environment populated by infinitely lived agents does not make any distinction between aspirations and habits possible. However, this distinction proves fundamental in an OLG setting because, while habits tend to reduce wealth inequality, aspirations tend to exacerbate it. Therefore, the claim that the introduction of past consumption references to the utility function does not help to generate more wealth inequality (e.g., Díaz *et al.*, 2003; Cagetti and De Nardi, 2008) should be qualified for an OLG economy where we can effectively distinguish between the two aforementioned features affecting individual preferences.

We also evaluate the effects of habits and aspirations on intergenerational mobility. We measure this mobility using the autocorrelation coefficient of asset holdings within a family. We show that, because of the induced reduction in the amount of bequests, aspirations tend to enhance intergenerational mobility. However, habits make savings more correlated with contemporaneous wages and this leads, in turn, to a larger intergenerational correlation of savings when aspirations are present.

Our results for an OLG economy with preferences displaying joy of giving differ in many respects from those of a related paper by Díaz *et al.* (2003), who considered an economy with infinitely lived agents. In order to make a proper comparison, we should consider the version of their model in which the elasticity of intertemporal substitution is not adjusted when habits are introduced. First, as we have already said, our model enables us to introduce the phenomenon of intergenerational transmission of tastes, which cannot be accommodated in non-OLG economies. Furthermore, our simple model allows us to obtain a closed-form expression for the comparative statics exercises when aspirations and habits are marginally introduced. Concerning the results, while Díaz *et al.* do not obtain a definite sign for the change in aggregate savings when habits are introduced, our life-cycle specification makes it possible to obtain an unambiguous increase in aggregate savings because of the induced shift in income from the adult to the old period of life. Finally, our demographic structure permits a sharp characterization of the effects of habits on intergenerational mobility within a family.

The paper is organized as follows. In Section II, we present the general model with habits and aspirations. In Section III, we characterize the optimal individual decisions. In Section IV, we analyze some dynamic stability issues of the intragenerational distribution of wealth. In Section V, we characterize the measure of intergenerational mobility in wealth. In Section VI, we conduct the comparative statics analysis of changes in the intensity of habits and aspirations on the steady-state values of the moments of the distribution of wealth and on intergenerational mobility. We conclude the paper in Section VII.

II. Preferences and Technology

Let us consider a small open OLG economy with a continuum of dynasties, where individuals live for three periods and a new generation is born in each period. Each individual has offspring in the second period of his life and the exogenous number of children per parent is $n \geq 1$. We assume that agents make economic decisions only during the last two periods of their lives.

Each agent inelastically supplies one time unit of labor in the second period of his life and is retired in the third period. Let us index each generation by the period in which its members work (i.e., when they are adults). In the initial period $t = 0$, the mass of dynasties is N_0, there is a continuum of individuals of mass 1 per dynasty, and dynasties are uniformly distributed on the interval $[0, N_0]$. The mass of dynasties N_0 is constant for all periods but the size of each dynasty grows and is equal to n^t in period t. The individuals belonging to each dynasty $j \in [0, N_0]$ are uniformly distributed on the interval $[0, n^t]$. Therefore, an individual i who is an adult in period t is fully described by his dynasty $j \in [0, N_0]$ and his position $m \in [0, n^t]$ within the dynasty to which he belongs. Therefore, we can write the individual index i as a two-dimensional vector, $i = (j, m) \in [0, N_0] \times [0, n^t] \equiv P_t$. Note that the Lebesgue measure of the population set P_t in period t is $N_t = N_0 n^t$.

There is a single commodity, which can be devoted to either consumption or investment. An adult individual $i \in P_t$ of generation t distributes his net labor income and inheritance between consumption and saving. The budget constraint faced by this worker i in period t is

$$w_t^i + b_t^i = c_t^i + s_t^i, \tag{1}$$

where w_t^i is the wage compensation of this worker, c_t^i is his amount of consumption (hereafter, adult consumption), b_t^i is the amount of inheritance he has received from parents, and s_t^i is the amount of savings.

When individuals are old, they receive a return on their savings, which is distributed between own consumption and bequests for their children. Therefore, the budget constraint of an old individual i belonging to generation t is

$$R_{t+1} s_t^i = x_{t+1}^i + n b_{t+1}^i, \tag{2}$$

where R_{t+1} is the gross rate of return on savings, b_{t+1}^i is the amount of bequests the individual leaves to each of his descendants (who were born in period t), and x_{t+1}^i is the amount of consumption of the old individual i in period $t + 1$ (hereafter, old consumption). Note that we are implicitly making an equal-treatment assumption so that all the direct descendants of the same individual i receive the same amount of inheritance.

We assume that in each period, individuals derive utility from the comparison of their consumption with a consumption reference. Note that during their first period of life, individuals neither work nor consume. However, as in de la Croix (1996), the member i of the generation born in period $t - 1$ inherits a certain level of aspirations a_t^i in period t. These aspirations are based on the standard of living achieved by his parents. More precisely, we assume that the inherited aspiration of an individual i of generation t is

$$a_t^i = c_{t-1}^i, \tag{3}$$

where c_{t-1}^i is the parent's amount of consumption when the parent was an adult (second period of life). We posit the following additive specification for the aspiration adjusted consumption $\hat{c}_t^i$ of an adult individual i belonging to generation t:

$$\hat{c}_t^i = c_t^i - \delta a_t^i, \quad \text{with } \delta \in [0, 1). \tag{4}$$

We set a common initial level of aspirations for all individuals at the initial date, $a_0^i = a_0$, for all $i \in P_0$. Therefore, when aspirations are present, the same amount of adult consumption will give rise to different levels of utility depending on the standards of living set by parental consumption. The adult individuals who have acquired higher aspirations because of their parents' experience of consumption will require a larger amount of consumption in order to achieve the same level of utility.

Preferences also exhibit habit formation, and hence the consumption reference of an old individual i of generation t is given by the consumption level reached in the previous period. As with aspirations, we assume that the habit-adjusted consumption $\hat{x}_{t+1}^i$ of an old individual i in period $t+1$ is given by the following additive function:

$$\hat{x}_{t+1}^i = x_{t+1}^i - \gamma c_t^i, \quad \text{with } \gamma \in [0, 1). \tag{5}$$

As occurs with aspirations, the old individuals who have experienced a larger amount of consumption when adults will need a larger amount of consumption when old in order to obtain the same level of utility as those individuals with fewer accumulated habits.

The individual i belonging to generation t derives utility from both aspiration-adjusted adult consumption and habit-adjusted old consumption. We posit the following time-additive and homothetic utility function, representing the preferences of the individual i belonging to generation t,

$$U\left(\hat{c}_t^i, \hat{x}_{t+1}^i, b_{t+1}^i\right) = u\left(\hat{c}_t^i\right) + \beta u\left(\hat{x}_{t+1}^i\right) + \rho u\left(b_{t+1}^i\right), \tag{6}$$

where β and ρ are positive. Note that we are generating positive bequests through a joy-of-giving motivation – as in Yaari (1965) or Abel (1986) – so that the amount of bequests enters directly as an argument in the utility function. There are other motives for intergenerational transfer, such as altruistic preferences, as in Barro (1974) and Becker (1981), where individuals derive utility from their children's indirect utility function, or paternalistic preferences, where individuals care about their offspring's level of consumption (Pollak, 1988). Under altruistic preferences, the last term in the utility (6) would be replaced by the indirect utility function of one's children, which is an increasing function of the amount of inheritance received by descendants. If preferences were paternalistic, the last term in the utility (6) would be replaced by the offspring's adult consumption, which, in turn, would be an increasing function of the amount b_{t+1} bequest. In both cases, the results would be qualitatively similar to those obtained under a joy-of-giving specification. However, a problem posed by these two alternative types of preferences is the potential existence of corner solutions when the bequest motive is not operative (i.e., when the amount of bequests in equilibrium is equal to zero). We avoid this problem by assuming joy-of-giving preferences displaying an Inada condition when the amount b_{t+1} of bequests tends to zero. In particular, for tractability, we assume a logarithmic utility, i.e.,

$$u(z) = \ln z.$$

Clearly, our results will be qualitatively similar if we assume instead a isoelastic utility,

$$u(z) = \frac{z^{1-\eta} - 1}{1 - \eta}, \quad \text{with } \eta > 0,$$

exhibiting a value for the parameter η sufficiently close to 1.

An alternative functional form found in the literature to introduce past consumption references to the utility function is the multiplicative. According to this formulation (see Abel, 1990; Díaz *et al.*, 2003), individuals derive utility from the ratio between current consumption and past reference rather than from their difference. Thus, the aspiration-adjusted young consumption and the habit-adjusted old consumption of the individual i belonging to generation t are

$$\hat{c}_t^i = \frac{c_t^i}{\left(a_t^i\right)^{\delta}}, \quad \text{with } \delta \in (0, 1) \tag{7}$$

and

$$\hat{x}_{t+1}^i = \frac{x_{t+1}^i}{\left(c_t^i\right)^{\gamma}}, \quad \text{with } \gamma \in (0, 1), \tag{8}$$

respectively. It is obvious that the additive formulation is much more tractable than the multiplicative. In particular, one of the problems with the multiplicative formulation is that the objective function faced by individuals could fail to be jointly concave with respect to the consumption vector. To see this, note that the amount of young consumption c_t^i of an individual i belonging to generation t will appear in both the numerator and the denominator of the first two terms of the sum of utilities (6), and this sum of concave functions of fractions is generically non-concave (see Alonso-Carrera *et al.*, 2005). Moreover, the qualitative results of the model remain unchanged under these two alternative formulations because they rely exclusively on the fact that a larger intensity of habits and aspirations (measured by the values of γ and δ, respectively) results in a larger marginal utility of current consumption. This effect on the marginal utility holds under both specifications. The multiplicative functional form should be adopted in stochastic environments in order to prevent the instantaneous utility function u from displaying a negative argument, which is a possibility under the additive formulation given in equations (4) and (5) when aggregate consumption fluctuates exogenously and cannot be accommodated through positive or negative savings. However, because we allow poor individuals when adult to borrow (negative saving) and rich individuals to lend (positive saving), the problem of obtaining negative values for the argument of the utility function u readily disappears under the assumption of pure idiosyncratic shocks, which we introduce next.

Let us assume that the good of this economy is produced by means of a production function displaying constant returns to scale in capital and efficient labor. In our small open economy, capital is fully mobile and labor is not mobile. Under competitive input markets, this implies that the rental price of a unit of capital is constant and equal to its international level r. Therefore, the gross rate of return on savings satisfies $R_{t+1} = 1 + r \equiv R$. Moreover, the equilibrium capital to efficient labor ratio becomes constant and, thus, the marginal productivity of an efficiency unit of labor (which is equal to the competitive real wage per efficiency unit) is also constant. This means that the labor income w_t^i received by individual i can be interpreted as the realization of the random number of efficiency units of labor owned by worker i in period t multiplied by the constant wage per efficiency unit.

We assume that the number of efficiency units of labor, and thus the wage w_t^i received by the worker i of generation t, is the realization of a random variable that is identically and independently distributed (i.i.d.) across individuals of the same generation and across time with a finite fourth moment, $\mathbb{E}[(w_t^i)^4] < \infty$. Finally, we assume that the random variable w_t^i has the mean $\bar{w}$ and the variance σ^2 for all i and t. Therefore, we are assuming that all workers experience idiosyncratic productivity shocks that are cross-sectionally (i.e., across all individuals of the same generation) and intergenerationally (i.e., across individuals belonging to different generations irrespective of the dynasty to which they belong) identical and independent. These shocks on labor income are assumed to be uninsurable.

The assumption of serial independence of wages allows us to highlight the contribution made by bequests and aspirations when we explain the correlation of wealth among members of the same family belonging to two consecutive generations. Serial correlation of labor income within a dynasty will automatically generate a dependence on consumption and wealth among different generations of the same dynasty. Thus, we abstract from this trivial, exogenous mechanism to link generations, and we focus exclusively on the contribution of inherited tastes and endogenous wealth transmission through bequests.

III. Optimal Consumption and Bequests

Individual i of generation t maximizes (6) with respect to $\{c_t^i, x_{t+1}^i, b_{t+1}^i, s_t^i\}$ subject to equations (1), (2), (4), and (5), taking as given a_t^i, b_t^i, w_t^i, and R_{t+1}. If we insert the competitive gross rate of return $R_{t+1} = R$ into the solution to this individual problem, we find the following linear demand functions for consumptions, bequests, and savings in equilibrium:

$$c_t^i = A\left(w_t^i + b_t^i\right) + Ba_t^i; \tag{9}$$

$$x_{t+1}^i = C\left(w_t^i + b_t^i\right) - Da_t^i; \tag{10}$$

$$b_{t+1}^i = E\left(w_t^i + b_t^i\right) - Fa_t^i; \tag{11}$$

$$s_t^i = G\left(w_t^i + b_t^i\right) - Ba_t^i, \tag{12}$$

where

$$A = \frac{R}{(R+\gamma)(1+\beta+\rho)}, \quad B = \frac{\delta(\beta+\rho)}{(1+\beta+\rho)}, \quad C = \frac{R[\beta(R+\gamma)+\gamma]}{(R+\gamma)(1+\beta+\rho)},$$
$$D = \frac{\delta(R\beta-\rho\gamma)}{(1+\beta+\rho)}, \quad E = \frac{\rho R}{n(1+\beta+\rho)}, \quad F = \frac{\delta\rho(R+\gamma)}{n(1+\beta+\rho)}, \quad \text{and}$$
$$G = \frac{R(\beta+\rho)+\gamma(1+\beta+\rho)}{(R+\gamma)(1+\beta+\rho)}. \tag{13}$$

Clearly, the optimal consumption, bequests, and savings of individual i depend on the realization of his productivity shock w_t^i, on the amount of inheritance b_t^i he has received, and, finally, on his aspiration level a_t^i, which is equal to the adult consumption of his parent c_{t-1}^i. Note also that adult and old consumption and bequests depend positively on both w_t^i and the amount b_t^i of inheritance. However, while adult consumption is increasing in the aspiration level a_t^i, savings and bequests are decreasing in a_t^i because aspirations force a shift in income towards adult consumption in order to mimic the parents' consumption experience. The effect of the aspiration level a_t^i on old consumption is generally ambiguous, although it becomes negative for low values of either the level of altruism parametrized by the value of ρ or the intensity of habits parametrized by the value of γ (see the expression for the coefficient D in equation (13)).

From the previous expressions for consumption at different ages, bequests, and savings, we can easily obtain the effect of changes in the preference parameters characterizing the strength of aspirations and habits on these variables. We immediate observe from equation (9) that, for given values for aspirations a_t^i, wages w_t^i, and inheritance b_t^i, adult consumption

c_t^i increases with the value of aspiration intensity δ and decreases with the value of habit intensity γ. This is because aspirations push adult consumption above the standards of living established by the parents, whereas habits push adult consumption down in order to decrease the stock of future habits. Concerning the amount of saving and old consumption, we obtain the following partial derivatives from equations (12) and (10), respectively:

$$\frac{\partial s_t^i}{\partial \gamma} = \frac{R\left(b_t^i + w^i\right)}{(R+\gamma)^2(1+\beta+\rho)} > 0;$$
$$\frac{\partial x_{t+1}^i}{\partial \gamma} = \frac{R^2\left(b_t^i + w^i\right) + \delta\rho(R+\gamma)^2 a_t^i}{(R+\gamma)^2(1+\beta+\rho)} > 0. \tag{14}$$

The sign of the partial derivative of saving and old consumption with respect to δ is immediate from equations (10), (12), and (13). Obviously, because of the aforementioned effects on adult consumption, aspirations reduce individual savings, while habits increase them. Moreover, because the initial wealth at the beginning of the last period of life decreases (increases) with aspiration (habit) intensity, the amount of old consumption x_{t+1}^i becomes smaller (larger) accordingly. Finally, we can clearly see from equation (11) and the expression for the coefficient F that both aspirations and habits reduce the amount of intergenerational transfer. On the one hand, aspirations lower the amount of savings and thus the wealth available for bequests. On the other hand, habits raise the amount of old consumption at the expense of lower bequests.

Another property of the above consumption, bequest, and saving functions refers to their sensitivity with respect to the idiosyncratic wage (or productivity) shocks. To this end, we only have to analyze how the coefficients of w_t^i in these functions vary with the preference parameters, δ and γ. We observe that none of these coefficients depends on the aspiration intensity parameter δ, which means that the conditional variances of consumption, bequests, and savings, given b_t^i and c_{t-1}^i, that is, $\mathrm{Var}(c_t^i|b_t^i, a_t^i)$, $\mathrm{Var}(x_{t+1}^i|b_t^i, a_t^i)$, $\mathrm{Var}(b_{t+1}^i|b_t^i, a_t^i)$, and $\mathrm{Var}(s_t^i|b_t^i, a_t^i)$, are all independent of the aspiration intensity. This is because these conditional variances are equal to the square of the coefficients of w_t^i in equations (9), (10), (11), and (12), respectively. Note that the parameter δ only affects the sensitivity of these functions with respect to parental consumption, which is assumed to be constant in this comparative statics analysis. On the contrary, changes in the value of the habit parameter γ affect the sensitivity of those functions with respect to wage shocks. Note that the value of γ refers to the importance of adult consumption in evaluating the utility arising from old consumption. Because adult consumption is decided by the individual under consideration and not by his parents, all decisions throughout the

Table 1. *Comparative statics of demand functions, conditional variances, and coefficients of variation*

	s_t^i	b_{t+1}^i	c_t^i	x_{t+1}^i
$\partial/\partial\delta$	<0	<0	>0	<0
$\partial/\partial\gamma$	>0	<0	<0	>0
$[\partial \mathrm{Var}(.\vert b_t^i, a_t^i)]/(\partial\delta)$	$=0$	$=0$	$=0$	$=0$
$[\partial \mathrm{Var}(.\vert b_t^i, a_t^i)]/(\partial\gamma)$	>0	$=0$	<0	>0
$[\partial \mathrm{CV}(.\vert b_t^i, a_t^i)]/(\partial\delta)$	>0	>0	<0	>0
$[\partial \mathrm{CV}(.\vert b_t^i, a_t^i)]/(\partial\gamma)$	>0 (if $\delta=0$)	>0	<0	<0

life cycle will be affected by the variation in the value of habit intensity. As habit intensity rises, individuals shift adult consumption towards the future in order to lower the stock of future habits. Therefore, old consumption will be more sensitive to wage shocks when habits are present, while the opposite will hold for adult consumption. A byproduct of the previous effect is that savings are more sensitive to wage shocks. Finally, the coefficient w_t^i in the bequest function (11) is independent of the habit parameter γ. This means that the sensitivity of bequests with respect to wage shocks is not affected by habit intensity either, because the induced changes in this preference parameter are all accommodated throughout the life cycle.

The first four rows in Table 1 summarize the previous comparative static exercises. As we have already said, the sensitivity of consumption, savings, and bequests with respect to wage shocks is measured by the corresponding conditional variance, given the amount of inheritance b_t^i and aspirations a_t^i. Because the average amount of consumption, savings, and bequests is also affected by the changes in the values of preferences parameters, we also include in the table this effect on the coefficient of variation, $\mathrm{CV}(\cdot) = [\mathrm{Var}(\cdot)]^{1/2}/\mathbb{E}(\cdot)$, which is a more appropriate measure of variability than variance when the mean is changing. Note that in order to compute this measure, we only need to know the mean $\bar{w}$ and the variance σ^2 of the i.i.d. stochastic process of wages w_t^i for all i and t. This measure is so simple that we can easily perform our intended comparative statics exercises. Other measures of variability, such as the Gini coefficient, require full knowledge of the distribution of wages and would make it impossible to obtain comparative statics results in closed form. Thus, because we are able to sign the effect on the coefficient of variation of the introduction of both habits and aspirations, we retain this measure of inequality throughout our analysis. Moreover, as González-Abril *et al.* (2010) argue, the coefficient of variation and the Gini coefficient are, in some sense, similar measures of the variability of a random variable.

IV. Dynamics of Consumption, Wealth, and Bequests

The dynamics of the economy within each dynasty is entirely governed by the system of stochastic difference equations formed by equations (9) and (11) after making $a_t^i = c_{t-1}^i$. Once the realization of the stochastic processes of young consumption and bequests has been obtained from these two equations, we immediately obtain the realization of the stochastic processes of savings and old consumption from equations (10) and (12).

To analyze the aggregate behavior of the economy, we should first obtain the aggregate levels per capita of the endogenous variables. To this end, note that the number of dynasties N_0 is constant for all periods, but the size of each dynasty varies and is equal to n^t in period t. Note also that, because of the presence of aspirations and bequests, the labor income shocks are transmitted intergenerationally within a dynasty. However, those shocks are not transmitted across dynasties because the amounts of consumption, bequests, and savings of two individuals belonging to two different dynasties depend on the i.i.d. stochastic process of wages within their own dynasties. So, let us consider the set of individuals $i = (j, m) \in P_t$ placed in position $m \in [0, n^t]$ within their respective dynasties in period t. Let us fix the value m and assume that the generic random variables $y_t^{(j,m)}$, $j \in [0, N_0]$, are i.i.d., with mean $\mathbb{E}[y_t^{(j,m)}] = \bar{y}_t$ and finite variance $\mathrm{Var}[y_t^{(j,m)}] = \mathrm{Var}(y_t)$ for all j and m. This assumption agrees with our scenario with i.i.d. stochastic processes of wages across individuals belonging to different dynasties and with a common initial aspiration level for all dynasties (i.e., $a_0^i = a_0$ for all i). Note that two individuals belonging to the same dynasty in period t have a partially common history of realizations of wages. In particular, two individuals who are brothers will share the same history of wages until period $t-1$ and an independent realization of the wage in period t. Therefore, these two individuals will not exhibit independent consumption, bequests, and savings when aspirations and bequests are present. By fixing the position $m \in [0, n^t]$ within each dynasty, we ensure that the i.i.d. assumption holds for the generic endogenous variables $y_t^{(j,m)}$, $j \in [0, N_0]$. Then, the law of large numbers for large economies (see Theorem 2 in Uhlig, 1996) implies that the average (or empirical mean) of the random variable $y_t^{(j,m)}$ in period t for a given position m satisfies

$$\frac{1}{N_0} \int_{[0,N_0]} y_t^{(j,m)} \, \mathrm{d}j = \bar{y}_t, \quad \text{with probability 1.}$$

The previous expression gives us the average value for individuals in the same position m in each dynasty. To find the average value of $y_t^{(j,m)}$ for the total population, we must average the previous values across all the positions $m \in [0, n^t]$. Formally, we can use Fubini's theorem to obtain

$$\begin{aligned}\frac{1}{N_t}\int_{P_t} y_t^i \,\mathrm{d}i &= \frac{1}{N_t}\int_{[0,N_0]\times[0,n^t]} y_t^{(j,m)}\,\mathrm{d}(j,m)\\ &= \frac{1}{N_0 n^t}\int_{[0,n^t]}\left[\int_{[0,N_0]} y_t^{(j,m)}\,\mathrm{d}j\right]\mathrm{d}m\\ &= \frac{1}{n^t}\int_{[0,n^t]}\left[\frac{1}{N_0}\int_{[0,N_0]} y_t^{(j,m)}\,\mathrm{d}j\right]\mathrm{d}m = \frac{1}{n^t}\int_{[0,n^t]}\bar{y}_t\,\mathrm{d}m\\ &= \frac{n^t\bar{y}_t}{n^t} = \bar{y}_t, \quad \text{with probability 1.}\end{aligned} \tag{15}$$

Because the term c_{t-1}^i in the aspirations equation (3) refers to the adult consumption in period $t-1$ of the parent of individual i belonging to generation t, the average stock of aspirations in period t is equal to the average consumption of the adult individuals in period $t-1$, $\bar{a}_t = \bar{c}_{t-1}$. Moreover, for every two pairs of individuals belonging to distinct dynasties, their demand functions (9), (10), (11), and (11) depend on the realizations of their corresponding i.i.d. stochastic processes of wages. Then, according to our previous discussion, we can use the law of large numbers for this large economy to compute the following average values of adult consumption and bequests within a generation by merely computing the expectation in both sides of equations (9) and (11):

$$\bar{c}_t = B\bar{c}_{t-1} + A\bar{b}_t + A\bar{w}; \tag{16}$$

$$\bar{b}_{t+1} = -F\bar{c}_{t-1} + E\bar{b}_t + E\bar{w}. \tag{17}$$

Here, $\bar{c}_t$ and $\bar{b}_t$ are the average amounts of adult consumption, bequests, and aspirations in period t, respectively.[3] It should be understood that the previous two equations hold with probability 1. The dynamic system composed of the difference equations (16) and (17) fully describes the evolution of the average values of adult consumption and bequests.

We could also analyze the dynamics of the second moments of the endogenous variables of our economy. It should be noted that in this large economy with i.i.d. labor income shocks, $\mathrm{Var}(c_t^i)$, $\mathrm{Var}(x_t^i)$, $\mathrm{Var}(s_t^i)$, and $\mathrm{Var}(b_t^i)$ coincide with the empirical intragenerational variances of adult consumption, old consumption, savings, and bequests at date t. To see this, we fix again position m within each dynasty and assume that the continuum of generic i.i.d. random variables $y_t^{(j,m)}$, $j \in [0, N_0]$, is i.i.d. with mean $\mathbb{E}[y_t^{(j,m)}] = \bar{y}_t$ and variance $\mathrm{Var}[y_t^{(j,m)}] = \mathrm{Var}(y_t)$ and has a finite

[3] Note that because wages w_t^i, $i \in P_t$, are cross-sectionally and serially i.i.d. for all individuals irrespective of their dynasty, the average wage of the economy in period t is $(1/N_t)\int_{P_t} w_t^i\,\mathrm{d}i = \bar{w}$, with probability 1, for all t.

fourth moment $\mathbb{E}\{[y_t^{(j,m)}]^4\} = \mathbb{E}[(y_t)^4] < \infty$, for all pairs (j, m). Then, the empirical variance of the continuum of random variables y_t^i, $i = (j, m) \in P_t$ is given by

$$\frac{1}{N_t} \int_{P_t} \left(y_t^i - \bar{y}\right)^2 \mathrm{d}i = \mathrm{Var}(y_t), \quad \text{with probability 1.} \tag{18}$$

Again, this follows from Theorem 2 in Uhlig (1996) and from replicating the same steps as in equation (15), because the random variables $[y_t^{(j,m)} - \bar{y}]^2$, $j \in [0, N_0]$, are also i.i.d. for a given m.

We can use a similar argument to show that the covariance $\mathrm{Cov}(c_t^i, b_{t+1}^i)$ coincides with the empirical covariance between adult consumption and the amount bequeathed to each descendant by individuals of generation t. Let us fix again position m within each dynasty. The random vectors $[c_t^{(j,m)}, b_{t+1}^{(j,m)}]$ are i.i.d. for $j \in [0, N_0]$, with $\mathrm{Cov}[c_t^{(j,m)}, b_{t+1}^{(j,m)}] = \mathrm{Cov}(c_t, b_{t+1})$ for all pairs (j, m). Then, the empirical covariance satisfies

$$\frac{1}{N_t} \int_{P_t} \left(c_t^i - \bar{c}_t\right)\left(b_{t+1}^i - \bar{b}_{t+1}\right) \mathrm{d}i = \mathrm{Cov}(c_t, b_{t+1}), \quad \text{with probability 1,}$$

because the random variables $[c_t^{(j,m)} - \bar{c}_t][b_{t+1}^{(j,m)} - \bar{b}_{t+1}]$, $j \in [0, N_0]$, are also i.i.d. for a given position m.

We have just seen that $\mathrm{Var}(c_t^i)$, $\mathrm{Var}(x_t^i)$, $\mathrm{Var}(s_t^i)$, and $\mathrm{Var}(b_t^i)$ coincide with the empirical intragenerational variances of c_t^i, x_t^i, s_t^i, and b_t^i in period t, which are equal to $\mathrm{Var}(c_t)$, $\mathrm{Var}(x_t)$, $\mathrm{Var}(s_t)$, and $\mathrm{Var}(b_t)$, respectively. Moreover, $\mathrm{Cov}(c_t^i, b_{t+1}^i)$ coincides with the empirical covariance between the amount of adult consumption and bequests left by the same individuals, which is equal to $\mathrm{Cov}(c_t, b_{t+1})$. Hereafter, we suppress the superscript i referring to the individual when we refer to the empirical second moments. Therefore, we can compute the variances of equations (9) and (11) to obtain

$$\mathrm{Var}(c_t) = B^2\mathrm{Var}(c_{t-1}) + A^2\mathrm{Var}(b_t) + 2AB\ \mathrm{Cov}(c_{t-1}, b_t) + A^2\sigma^2, \tag{19}$$

and

$$\mathrm{Var}(b_{t+1}) = F^2\mathrm{Var}(c_{t-1}) + E^2\mathrm{Var}(b_t) - 2EF\ \mathrm{Cov}(c_{t-1}, b_t) + E^2\sigma^2, \tag{20}$$

where we have again used the aspirations equation (3).[4] In order to close the system referring to the dynamics of the second-order moments, we need to compute the covariance $\mathrm{Cov}(c_t, b_{t+1})$ between the amount of adult consumption and the amount bequeathed to each of his descendants by a

[4] Because wages w_t^i are cross-sectionally and serially i.i.d. and $\mathbb{E}[(w_t^i)^4] = \mathbb{E}(w^4)$ is finite for all $i \in P_t$, the empirical variance of wages in this economy in period t is $(1/N_t)\int_{P_t}(w_t^i - \bar{w})^2\,\mathrm{d}i = \sigma^2$, with probability 1, for all t.

generic individual. This covariance is immediately obtained from expressions (9) and (11),

$$\mathrm{Cov}(c_t, b_{t+1}) = -BF\,\mathrm{Var}(c_{t-1}) + AE\,\mathrm{Var}(b_t) \\ + (BE - AF)\,\mathrm{Cov}(c_{t-1}, b_t) + AE\,\sigma^2. \tag{21}$$

Next, we find the steady-state values of the first and second empirical moments of the endogenous variables of our economy, and we characterize their dynamics. The steady-state values of average adult consumption and bequests are given by

$$\bar{c} = \frac{nR\bar{w}}{\{n + [n(\beta+\rho) - \rho R](1-\delta)\}(R+\gamma)} \tag{22}$$

and

$$\bar{b} = \frac{\rho(1-\delta)R\bar{w}}{n + [n(\beta+\rho) - \rho R](1-\delta)}. \tag{23}$$

These values are obtained merely by making $\bar{c}_t = \bar{c}_{t-1} = \bar{c}$ and $\bar{b}_{t+1} = \bar{b}_{t+1} = \bar{b}$ in equations (16) and (17), then solving for $\bar{c}$ and $\bar{b}$, and using the expressions for A, B, E, and F given in equation (13). Moreover, taking expectations in both sides of equation (12) and evaluating the resulting equation at the steady-state average values of adult consumption and bequests, we obtain the steady-state average amount of savings:

$$\bar{s} = \frac{[(1-\delta)(\beta+\rho)(R+\gamma) + \gamma]n\bar{w}}{\{n + [n(\beta+\rho) - \rho R](1-\delta)\}(R+\gamma)}. \tag{24}$$

Similarly, using equations (19), (20), and (21), the values of the coefficients given in equation (13), and making $\mathrm{Var}(c_t) = \mathrm{Var}(c)$, $\mathrm{Var}(b_t) = \mathrm{Var}(b)$, and $\mathrm{Cov}(c_t^i, b_{t+1}^i) = \mathrm{Cov}(c, b')$ for all pairs (i, t), we can compute the steady-state values of the variances of adult consumption and bequests, $\mathrm{Var}(c)$ and $\mathrm{Var}(b)$, and the corresponding steady-state value of the covariance $\mathrm{Cov}(c, b')$ between adult consumption c of an individual and bequests b' left by this individual to each descendant:

$$\mathrm{Var}(c) = \{n^2R^2[n(1+\beta+\rho) + R\delta\rho]\sigma^2\} \\ \times [[n(1+\beta+\rho) - R\delta\rho]\{n + [n(\beta+\rho) + \rho R](1+\delta)\} \\ \times \{n + [n(\beta+\rho) - \rho R](1-\delta)\}(R+\gamma)^2]^{-1}, \tag{25}$$

$$\mathrm{Var}(b) = [\rho^2R^2\{n[(\beta+\rho)(1-\delta^2) + 1 + \delta^2] - R\delta\rho(1-\delta^2)\}\sigma^2] \\ \times [[n(1+\beta+\rho) - R\delta\rho]\{n + [n(\beta+\rho) - \rho R](1-\delta)\} \\ \times \{n + [n(\beta+\rho) + \rho R](1+\delta)\}]^{-1}, \tag{26}$$

and

$$\begin{aligned}\mathrm{Cov}(c, b') = \{n^2 \rho R^2 [(1-\delta^2)(\beta+\rho)+1]\sigma^2\}[[n(1+\beta+\rho) - R\delta\rho] \\ \times \{n + [n(\beta+\rho)+\rho R](1+\delta)\} \\ \times \{n + [n(\beta+\rho)-\rho R](1-\delta)\}(R+\gamma)]^{-1}. \qquad (27)\end{aligned}$$

Moreover, from equations (12) and (3), we obtain the variance of saving,

$$\mathrm{Var}(s_t) = G^2 \mathrm{Var}(b_t) + B^2 \mathrm{Var}(c_{t-1}) - 2BG\,\mathrm{Cov}(c_{t-1}, b_t) + G^2\sigma^2,$$

so that the steady-state value of the variance of saving becomes

$$\mathrm{Var}(s) = G^2 \mathrm{Var}(b) + B^2 \mathrm{Var}(c) - 2BG\,\mathrm{Cov}(c, b') + G^2\sigma^2, \qquad (28)$$

where $\mathrm{Var}(c)$, $\mathrm{Var}(b)$, and $\mathrm{Cov}(c, b')$ are given in equations (25), (26), and (27), respectively.

Next, we proceed to find the conditions under which the first and second central moments of the joint distribution of the endogenous variables of our model converge to their steady-state values. The following lemma provides a sufficient condition for the dynamic stability of the first moments of the intragenerational distribution of adult consumption and bequests.

Lemma 1. *If $\rho R/n(1+\beta+\rho) < 1$ and the aspiration intensity δ is sufficiently small, then the dynamic system formed by equations* (16) *and* (17) *converges monotonically to the steady-state value for average adult consumption and bequests given by* (22) *and* (23)*, respectively.*

For sufficiently high values of aspiration intensity, i.e., when

$$\delta > \frac{\rho R}{n}\left[\frac{1-(1+\beta+\rho)^{1/2}}{\beta+\rho}\right]^2 \equiv K,$$

the first moments of aggregate consumption and bequests exhibit cycles. If the condition $\rho R/n(1+\beta+\rho) \in (0, 1)$ for dynamic stability is imposed, it is plain to see that the bifurcation value K for the aspiration intensity is strictly smaller than one. The role of aspirations in the emergence of cycles has already been exhaustively analyzed by de la Croix and Michel (1999) for an economy with no intergenerational transmission of wealth. Note that when aspirations are absent, $\delta = 0$, the condition $\rho R/n(1+\beta+\rho) < 1$ is necessary and sufficient for the convergence of the means of the endogenous variables of our economy. As occurs in the traditional *Ak* models of growth, under the linear demand functions (16) and (17), it is necessary to impose an upper bound in the return R on savings in order prevent the dynamic system from exhibiting an unbounded growth path of the average values of consumption and bequests per capita.

Concerning the stability of the dynamic system driving the evolution of second-order moments formed by equations (19), (20), and (21), we can proceed in a similar fashion. The following lemma provides a sufficient condition for dynamic stability of the second moments of the intragenerational distribution of consumption and bequests.

Lemma 2. *If $\rho R/n(1+\beta+\rho) < 1$ and the aspiration intensity δ is sufficiently small, then the dynamic system formed by equations* (19), (20), *and* (21) *converges to the steady-state value for the variance of adult consumption, variance of bequests, and covariance between adult consumption and the amount bequeathed to each descendant given by equations* (25), (26), *and* (27), *respectively.*

The condition on the aspiration intensity δ for convergence of the second moments is more stringent than for convergence of means. This is because random variables with finite second moments have finite first moments, but the converse is not true. For the remainder of the paper, we maintain the assumption $\rho R/n(1+\beta+\rho) < 1$, which together with a sufficiently small value of the parameter δ, ensures the dynamic stability of the first and second moments of the intragenerational distribution of adult consumption and bequests.

V. Intergenerational Mobility

To perform an analysis of intergenerational mobility in our economy, we should analyze the behavior of the correlation coefficient between s_{t+1}^i and s_t^i, $\mathrm{Corr}(s_{t+1}^i, s_t^i)$; that is, between the amount s_t^i of assets held by a generic individual i and the amount s_{t+1}^i held by one of his children. If bequests and aspirations were absent, this autocorrelation would be equal to zero and thus we would obtain perfect mobility because wages are i.i.d. If we had perfect correlation of asset holdings (i.e., $\mathrm{Corr}(s_{t+1}^i, s_t^i) = 1$), then intergenerational mobility would be null.

It is important to note that, even if altruism is absent, the presence of aspirations induces a wealth correlation across the members of consecutive generations within the same family. This is because aspirations induce a correlation between the amount of parental consumption and the profile of consumption and saving of their descendants.

As before, we should point out that the covariance of the stochastic process of saving between two consecutive individuals belonging to the same family coincides with the empirical autocorrelation. To see this, let us fix again the positions m and m' within each dynasty, so that the individual (j, m) is the parent of individual (j, m'). Because labor income shocks are i.i.d. across individuals belonging to different dynasties, the random vectors $[s_t^{(j,m)}, s_{t+1}^{(j,m')}]$ are i.i.d. for $j \in [0, N_0]$, with $\mathrm{Cov}[s_t^{(j,m)}, s_{t+1}^{(j,m')}] =$

$\mathrm{Cov}(s_t, s_{t+1})$ for all j, m, and m'. Therefore, the empirical covariance satisfies

$$\frac{1}{N_t}\int_{P_t}\left(s_t^i - \bar{s}\right)\left(s_{t+1}^i - \bar{s}\right)\mathrm{d}i = \mathrm{Cov}(s_t, s_{t+1}), \quad \text{with probability 1,} \tag{29}$$

because the random variables $[s_t^{(j,m)} - \bar{s}][s_{t+1}^{(j,m')} - \bar{s}]$, $j \in [0, N_0]$, are also i.i.d. for given positions m and m', with the individual (j, m) being the parent of individual (j, m').

Concerning the autocorrelation of the stochastic process of saving, the following holds:

$$\mathrm{Corr}\left(s_{t+1}^i, s_t^i\right) = \frac{\mathrm{Cov}\left(s_{t+1}^i, s_t^i\right)}{\left[\mathrm{Var}\left(s_{t+1}^i\right)\right]^{1/2}\cdot\left[\mathrm{Var}\left(s_t^i\right)\right]^{1/2}} = \frac{\mathrm{Cov}(s_{t+1}, s_t)}{\mathrm{Var}(s_t)},$$

as follows equations (18) and (29). Therefore, the autocorrelation coefficient of the stochastic process of saving between parents and children coincides with its empirical autocorrelation coefficient. In the following lemma, we provide the formula for the empirical covariance of $\mathrm{Cov}(s_{t+1}, s_t)$ and establish its convergence towards its steady-state value, $\mathrm{Cov}(s', s)$, where s are the savings of a generic individual and s' are the savings of a direct descendant of that individual.

Lemma 3. *The empirical intergenerational covariance of wealth in period t is given by*

$$\mathrm{Cov}(s_{t+1}, s_t) = GH[\sigma^2 + \mathrm{Var}(b_t)] + BI\,\mathrm{Var}(c_{t-1}) - (BH + GI)\,\mathrm{Cov}(c_{t-1}, b_t),$$

where

$$H = EG - AB, \quad I = B^2 + FG,$$

and A, B, E, F, and G are the coefficients whose values are given in equation (13)*. Moreover, if $\rho R/n(1+\beta+\rho) < 1$ and the aspiration intensity δ is sufficiently small, then* $\mathrm{Cov}(s_{t+1}, s_t)$ *converges to its steady-state value*

$$\mathrm{Cov}(s', s) = GH[\sigma^2 + \mathrm{Var}(b)] + BI\,\mathrm{Var}(c) - (BH + GI)\,\mathrm{Cov}(c, b'), \tag{30}$$

where $\mathrm{Var}(c)$, $\mathrm{Var}(b)$, *and* $\mathrm{Cov}(c, b')$ *are given in equations* (25), (26), *and* (27), *respectively.*

Because expression (28) gives us $\mathrm{Var}(s)$, we can use equation (30) to find an explicit expression for the steady-state value of the autocorrelation coefficient of wealth,

$$\mathrm{Corr}(s', s) = \frac{\mathrm{Cov}(s', s)}{\mathrm{Var}(s)}.$$

Using a similar procedure, we can find the expressions for the autocorrelation coefficient of adult consumption $\mathrm{Corr}(c', c)$, of old consumption $\mathrm{Corr}(x', x)$, and of bequests $\mathrm{Corr}(b', b)$. In Section VI, we conduct the corresponding comparative statics exercise on the steady-state values of these autocorrelation coefficients to characterize the effects on intergenerational mobility of changes in the intensity of habits and aspirations.

VI. Effects of Habits and Aspirations on the Intragenerational Distribution of Wealth and Intergenerational Mobility

In this section, we characterize the effects of habits and aspirations on the steady-state values of the first two moments of the distribution of wealth. Note that those properties of individual preferences affect the amount of savings because they modify the evaluation of the utility derived from consumption in the two periods of life. Moreover, in our economy, individuals' savings are equal to their asset holdings at the beginning of their last period of life.

By differentiating equations (24) and (23) with respect to δ and γ measuring the intensity of aspirations and habits, respectively, we obtain the following effects on the average amount of savings and bequests:

$$\frac{\partial \bar{s}}{\partial \delta} = -\frac{[n(\beta+\rho)+\gamma\rho]Rn\bar{w}}{\{n+[n(\beta+\rho)-\rho R](1-\delta)\}^2(R+\gamma)} < 0, \tag{31}$$

$$\frac{\partial \bar{s}}{\partial \gamma} = \frac{Rn\bar{w}}{\{n+[n(\beta+\rho)-\rho R](1-\delta)\}(R+\gamma)^2} > 0, \tag{32}$$

$$\frac{\partial \bar{b}}{\partial \delta} = \frac{-Rn\rho\bar{w}}{\{n+[n(\beta+\rho)-\rho R](1-\delta)\}^2} < 0, \tag{33}$$

and

$$\frac{\partial \bar{b}}{\partial \gamma} = 0. \tag{34}$$

The derivative $\partial\bar{s}/\partial\gamma$ is positive because it has a negative numerator and a positive denominator. To see the latter sign, note that

$$\begin{aligned} n+[n(\beta+\rho)-\rho R](1-\delta) &= n[(1-\delta)(1+\beta+\rho)+\delta]-\rho R(1-\delta) \\ &> n(1-\delta)(1+\beta+\rho)-\rho R(1-\delta) \\ &= [n(1+\beta+\rho)-\rho R](1-\delta) > 0, \end{aligned} \tag{35}$$

where the last inequality is a consequence of the dynamic stability assumption, $\rho R/n(1+\beta+\rho) < 1$.

An increase in the value of the aspiration intensity δ increases the marginal utility of an extra unit of adult consumption because individuals are more sensitive to their parents' level of consumption when evaluating their own adult consumption. Therefore, individuals optimally increase their adult consumption, and thus the amount of savings, old consumption, and inheritance received by their children should decrease.

Concerning the effect of an increase in the value of the habit formation parameter γ, we note that individuals experience an increase in the marginal valuation of their old consumption as they more intensely internalize their past adult consumption. Thus, they optimally decide to shift consumption from adulthood to old age by saving more (see equation (32)). On the one hand, the reduction in adult consumption lowers the stock of habits and, on the other hand, the increase in old consumption is the optimal response to the increase in the marginal utility of old consumption. We also note that the aggregate effects of stronger habits are accommodated throughout the an individual's life cycle because the aggregate amount of bequests remains unchanged (see equation (34)).

We can now also analyze how the changes in the values of δ and γ affect the intragenerational variability of wealth. First, we concentrate our analysis on the variability of savings, which fully determines the amount of assets held by individuals at the beginning of the last period of their lives. Because the average amount of savings is also affected by these changes, it seems appropriate to perform our comparative statics exercise on the coefficient of variation, $\mathrm{CV}(s) = [\mathrm{Var}(s)]^{1/2}/\bar{s}$. As we have already said, we choose this measure of variability because it is simple enough for us to obtain explicit signs for our intended comparative static exercises. Moreover, because of the linearity of the saving function (12), we can easily compute the coefficient of variation from our knowledge of the values of the first two moments of the distribution of wages. Other measures of inequality, such as the Gini coefficient, require a complete description of the distribution of wages. Moreover, with these measures, the comparative statics results will not arise from closed-form expressions but from simulations (see Bossmann *et al.*, 2007).

By combining equations (25), (26), (27), and (28), and after some algebra, we obtain the following derivative of the coefficient of variation,

$$\left.\frac{\partial \mathrm{CV}(s)}{\partial \delta}\right|_{\delta=\gamma=0} = \frac{n^2(1+\beta+\rho)\sigma}{[n^2(1+\beta+\rho)^2 - \rho^2 R^2]^{1/2}[n(1+\beta+\rho)+\rho R]\bar{w}} > 0, \tag{36}$$

where the sign of the previous expression follows immediately under our maintained condition of dynamic stability, $\rho R/n(1+\beta+\rho) < 1$. Our comparative statics exercise on the coefficient of variation of savings is

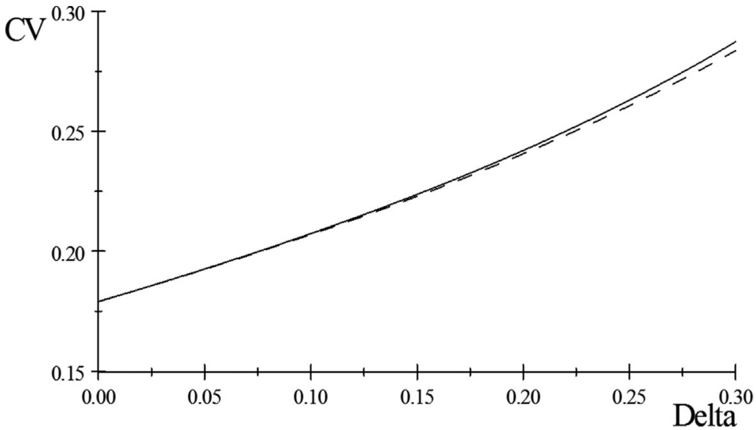

Fig. 1. Effects of δ on the coefficient of variation CV(s) of wealth: solid line, $\gamma = 0$; dashed line: $\gamma = 1/4$

conducted in a fairly restrictive scenario, which enables us to unambiguously sign the effects of stronger aspirations. We evaluate the derivative of CV(s) with respect to δ at point $\delta = \gamma = 0$; that is, we analyze the effect of the marginal introduction of aspirations to an economy when habits are absent or present on a small scale. Thus, the marginal introduction of aspirations increases the variability of wealth in this case. When aspirations are introduced, the variability of the asset holdings of an individual is magnified because it does not depend on the fluctuation of his own wage only but also on the shocks to the wages of his predecessors. This effect, combined with the decrease in the amount of savings (see equation (31), results in a larger value of the coefficient of variation of savings.

The evaluation of the partial derivative (36) for arbitrary values of δ and γ cannot be explicitly signed. In order to evaluate the robustness of the sign of that derivative, we conduct a numerical analysis. We choose the values of the preference parameters $\beta = 1/2$ and $\rho = 1/2$. Moreover, following Iacoviello (2008), we choose the value of the average wage $\bar{w} = 2/3$ and make the cross-sectional standard deviation of the log of earnings equal to 0.5173. Therefore, we set the associated variance of wages equal to $\sigma^2 = (2/3)^2[\exp(0.5173^2) - 1] = 0.13637$, which amounts to a cross-sectional coefficient of variation of wages equal to $\sigma/\bar{w} = 0.55392$. We assume a constant population, $n = 1$. Finally, we choose an interest rate per year of 4 percent and we consider that each period lasts for 30 years, so that $R = (1.04)^{30} = 3.2434$. We maintain these parameter values for the remaining numerical exercises unless otherwise specified. In Figure 1, we observe that the positive effect of aspirations on the coefficient of variation of asset holdings is preserved for all values of δ and for different combinations of values for the habit parameter. Note that we restrict the domain of the aspiration parameter δ to lie in the interval (A3), so that $\delta \in [0, 0.27824)$.

Concerning the implications for the intragenerational variability of wealth of changes in habit intensity, it can be shown that

$$\left.\frac{\partial \mathrm{CV}(s)}{\partial \gamma}\right|_{\delta=0} = 0.$$

Therefore, we observe that habits cannot affect the level of intragenerational variation of wealth if aspirations are not present. To understand this result, note that, if aspiration are not present ($\delta = 0$), the effect of a change in habit intensity γ results exclusively in an adjustment in the allocation consumption throughout the life cycle, and parental consumption plays no role in this allocation of consumption (see equations (9) and (10), and the expressions for the constants B and D given in equation (13). Moreover, the optimal amount devoted to bequests remains unchanged after this reallocation of consumption (see equation (11) and the expressions for E and F given in equation (13) so that the distribution of bequests b_t^i is left unchanged. Note that the saving function (12) when aspirations are absent becomes simply $s_t^i = G(w_t^i + b_t^i$, where the coefficient G is increasing in the habit intensity γ (see equation (14)). Therefore, an increase in habit intensity results in a proportional increase in the steady-state values of both the standard deviation and the mean of savings, which leaves the corresponding coefficient of variation unchanged. This means that changes in habit intensity affect the intergenerational transmission of productivity shocks only through inherited tastes. Moreover, we can compute the following derivative:

$$\begin{aligned}\left.\frac{\partial \mathrm{CV}(s)}{\partial \gamma}\right|_{\gamma=0,\delta>0} = &-\langle [n\delta(1+\delta)\{n + [n(\beta+\rho) - \rho R](1-\delta)\}^{3/2}\sigma] \\ &\times [(1-\delta)^2 Rn(\beta+\rho)\{n(1+\delta^2) \\ &+ [n(\beta+\rho) - R\delta\rho](1-\delta^2)\}^{1/2} \\ &\times \{n + (1+\delta)[n(\beta+\rho) + \rho R]\}^{1/2} \\ &\times [n(1+\beta+\rho) - \rho R\delta]^{1/2}\bar{w}]^{-1}\rangle < 0. \end{aligned} \qquad (37)$$

Here, the negative sign follows again from equation (35) under the assumption $\rho R/n(1+\beta+\rho) < 1$. Note also that the previous derivative (37) gives us the effect on the variability of asset holdings of the marginal introduction of habits when aspirations are present. Clearly, when habits are introduced, a shock in wages is more evenly distributed among adult and old consumption because habits enhance consumption smoothing throughout the

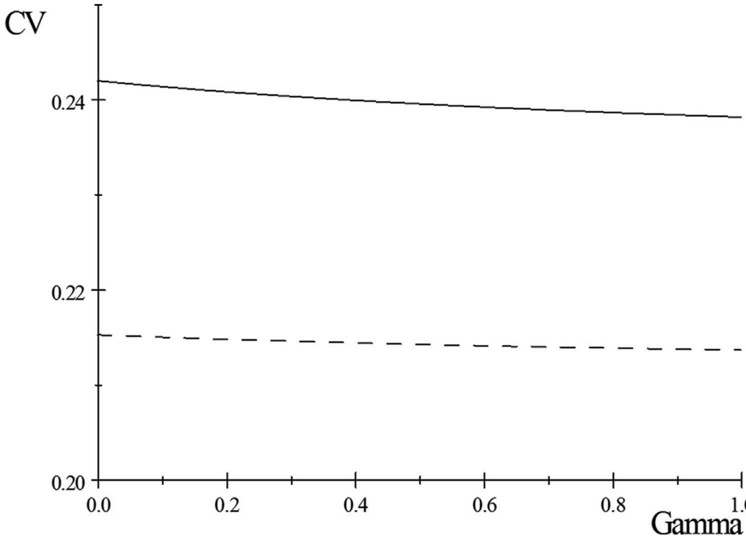

Fig. 2. Effects of γ on the coefficient of variation CV(s) of wealth: solid line, $\delta = 1/5$; dashed line, $\delta = 1/8$

life cycle, and this results in a larger variance of savings. However, the increase in the average amount of savings (see equation (32)) leads to a reduction in the coefficient of variation CV(s) of savings, as shown in equation (37). In Figure 2, we observe that the negative sign of the derivative (37) is preserved for strictly positive values of both the habit parameter γ and the aspiration parameter δ. We have also checked the robustness of the sign of the derivative for different values of the aspiration intensity δ in the interval $[0, 0.27824)$.

Thus, we have observed that, while aspirations tend to increase inequality in wealth distribution, habits tend to decrease it. The latter result agrees with the observation made by Cagetti and De Nardi (2008), who have claimed that the introduction of habit formation does not help to explain the large empirical inequality in the distribution of wealth. However, our OLG model enables the introduction of aspirations as another channel through which the amount of past consumption affects the utility delivered by current consumption. In this way, the introduction of aspirations does result in larger wealth inequality. Therefore, the distinction between these two features in individual preferences has dramatic consequences for the comparative statics exercises involving the characteristics of wealth distribution.

In Table 2, we summarize the effects of changes in aspiration and habit intensity on the steady-state values of the first and second moments of

Table 2. *Effects of changes in aspiration and habit intensity on the steady-state values of the moments*

	s	b	c	x
$\partial\mathbb{E}(\cdot)/\partial\delta$	< 0	< 0	> 0	< 0
$\partial\mathbb{E}(\cdot)/\partial\gamma$	> 0	$= 0$	< 0	> 0
$[\partial\mathrm{Var}(\cdot)/\partial\delta]\|_{\delta=\gamma=0}$	< 0	< 0	> 0	< 0
$[\partial\mathrm{Var}(\cdot)/\partial\gamma]\|_{\delta=\gamma=0}$	> 0	$= 0$	< 0	> 0
$[\partial\mathrm{CV}(\cdot)/\partial\delta]\|_{\delta=\gamma=0}$	> 0	> 0	< 0 (if $\rho = 0$)	< 0 (if $\rho = 0$)
$[\partial\mathrm{CV}(\cdot)/\partial\gamma]\|_{\gamma=0}$	< 0	$= 0$	$= 0$	< 0

all the endogenous variables in the model. Note that the changes in the coefficients of variation of bequests and savings are mostly driven by the changes in the mean of these variables rather than by those of the variances. This means that whenever the variance and the mean move in the same direction, the resulting effect on the coefficient of variation will be the opposite of that of the variance. Thus, the effects on the variability of wealth (savings and bequests) depend crucially on the statistical measure we use in this respect. Another lesson that we can infer from that table is that the effects of aspirations on wealth at the end of the last period (i.e., the amount of bequests) are the same as those on wealth at the beginning of the last period of life (i.e., the amount of savings). Finally, the effect of habits on the variance and mean of adult consumption is of the same magnitude and thus the coefficient of variation remains unchanged when habit intensity varies.

We can now proceed with an analysis of the effects of habit and aspiration intensities γ and δ on the level of intergenerational mobility within a family, which is characterized in the long run by the steady-state value of the autocorrelation coefficient of asset holdings, $\mathrm{Corr}(s', s)$. To this end, we compute the derivatives of the autocorrelation coefficient $\mathrm{Corr}(s', s)$, which was obtained in Section V, with respect to the parameters representing the aspiration and habit intensities. The corresponding partial derivatives are

$$\left.\frac{\partial \mathrm{Corr}(s', s)}{\partial \delta}\right|_{\delta=\gamma=0} = -\frac{1}{(1+\beta+\rho)} < 0 \tag{38}$$

and

$$\left.\frac{\partial \mathrm{Corr}(s', s)}{\partial \gamma}\right|_{\gamma=\rho=0,\delta>0} = \frac{\delta(1-\delta^2)[(1+\beta)^2-\beta^2\delta^2]}{R\beta[1+\delta^2+\beta(1-\delta^2)]^2} > 0. \tag{39}$$

Again, these derivatives characterize the effects of the marginal introduction of either aspirations or habits. Moreover, the derivative of the correlation coefficient $\mathrm{Corr}(s', s)$ with respect to the habit parameter γ can only be explicitly signed when the degree of altruism, which is parametrized by ρ, is sufficiently low. Note that if we evaluate the derivative (39) when there are no aspirations, we clearly obtain

$$\left.\frac{\partial \mathrm{Corr}(s', s)}{\partial \gamma}\right|_{\delta=\gamma=0} = 0.$$

Thus, again, changes in habits only affect the level of intragenerational mobility through the transmission of tastes across the generations within the same family. We observe that the introduction of aspirations and habits has opposite effects on intergenerational mobility. On the one hand, the introduction of aspirations raises the degree of mobility. Because the marginal utility of adult consumption increases when aspirations are introduced, workers tend to increase their consumption by reducing both their savings and the amount of bequests they plan to leave to their children (see equation (33)). Obviously, this results in a smaller correlation between the assets of parents and their direct descendants.

On the other hand, when habits are introduced, workers wish to smoothen their consumption more throughout their life cycle. Hence, a positive shock in their labor income results in a larger increase in their savings, which is aimed at shifting adult consumption towards old consumption. In the presence of aspirations, the savings levels of individuals belonging to consecutive generations become correlated, and this correlation does indeed become larger as each individual's saving becomes more sensitive to productivity shocks. Thus, we conclude that the introduction of habits results in an increase in the correlation of wealth between members of consecutive generations within the same family.

In Figures 3 and 4, we conduct a numerical analysis to check the robustness of the signs of the derivatives (38) and (39). When aspiration intensity increases, individuals increase their adult consumption in response to the larger parental consumption by reducing their savings. This negative effect of aspirations on asset autocorrelation is preserved through the numerical examples in Figure 3 with $\delta \in [0, 0.27824)$. Note that because we have introduced altruism into these examples, bequests are positive and, hence, the autocorrelation $\mathrm{Corr}(s, s')$ is positive as a consequence of the intergenerational transmission of wealth.

In Figures 4 and 5, we consider strictly positive values of the aspiration parameter and two values for the altruism parameter, $\rho = 0$ (Figure 4) and $\rho = 1/2$ (Figure 5). When there is no altruism, $\rho = 0$, we observe in Figure 4 that the autocorrelation of asset holding is negative. Obviously, if aspirations are present in an economy with no habits and no altruism, then adult individuals seek to mimic the consumption level of their parents. Thus, because labor income is uncorrelated across generations, the savings

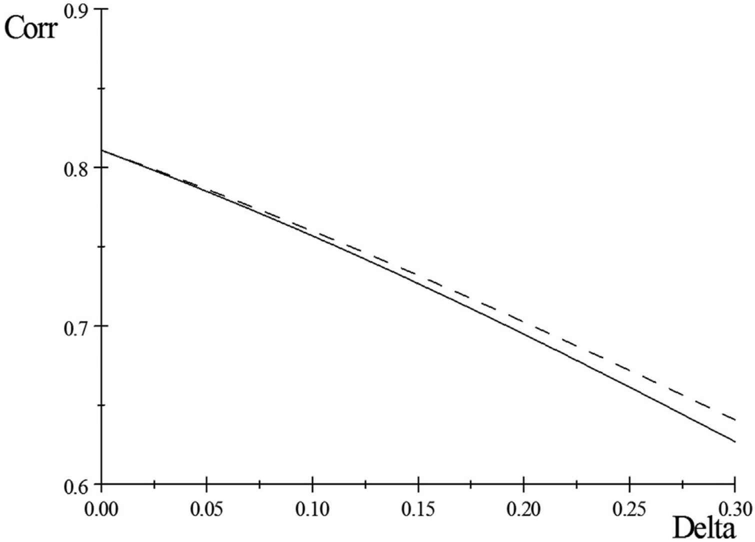

Fig. 3. Effects of δ on the autocorrelation coefficient $\mathrm{Corr}(s, s')$ of wealth: solid line, $\gamma = 0$; dashed line, $\gamma = 1/4$

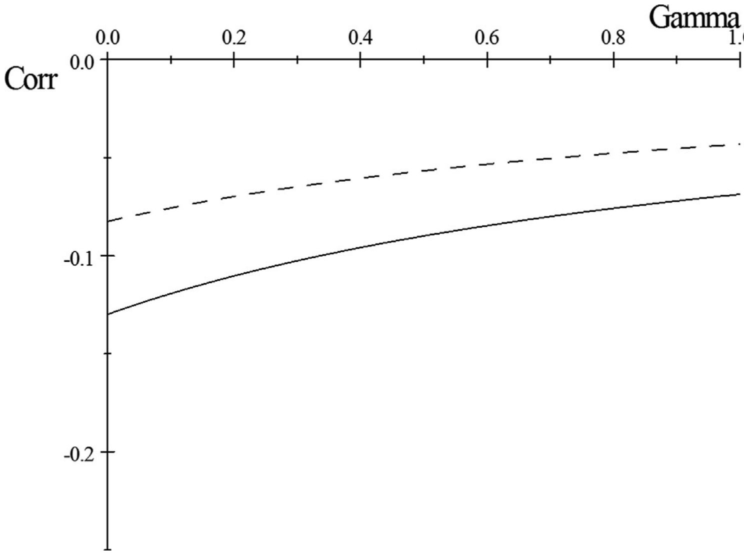

Fig. 4. Effects of γ on the autocorrelation coefficient $\mathrm{Corr}(s, s')$ of wealth: solid line, $\rho = 0, \delta = 1/5$; dashed line, $\rho = 0, \delta = 1/8$

of two consecutive members of the same family become negatively correlated. Obviously, as individuals seek to acquire the same standard of living as their parents, the direct descendants of rich individuals save very little, on average, to finance their adult consumption. The relationship

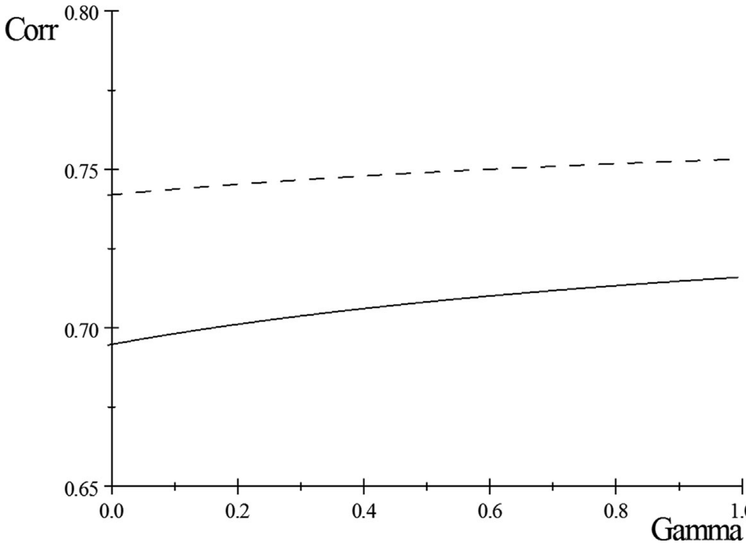

Fig. 5. Effects of γ on the autocorrelation coefficient Corr(s, s') of wealth: solid line, $\rho = 1/2$, $\delta = 1/5$; dashed line, $\rho = 1/2$, $\delta = 1/8$

Table 3. *Effects of changes in aspiration and habit intensity on the autocorrelation coefficient*

	s	b	c	x
$[\partial \mathrm{Corr}(\cdot)/\partial\delta]\|_{\delta=\gamma=0}$	< 0	< 0	> 0 (if $\rho = 0$)	< 0
$[\partial \mathrm{Corr}(\cdot)/\partial\gamma]\|_{\gamma=0}$	> 0 (if $\rho = 0$)	$= 0$	$= 0$	> 0 (if $\rho = 0$)

between the autocorrelation Corr(s, s') and the value of the habit parameter γ is positive, which agrees with equation (39). In Figure 5, we consider the case with $\rho = 1/2$. We see that the wealth autocorrelation becomes positive because of the introduction of altruism and the corresponding positive bequests. Here, the positive relationship between Corr(s, s') and the intensity of habits is preserved.

In Table 3, we summarize the effects of changes in aspiration and habit intensity on the autocorrelation coefficients of all the endogenous variables in the model. We observe that the sign of the effects on old consumption is the same as that on saving. On the one hand, when aspirations are introduced, only the autocorrelation of adult consumption increases, because this consumption determines the level of aspirations that individuals have to overcome, while the autocorrelations of old consumption, savings, and bequests decrease. On the other hand, the introduction of habit formation only affects the transfer of wealth from the adult to the old period of life, which leaves the autocorrelation of both bequests and adult consumption unchanged.

VII. Conclusion

We have developed a simple model that enables us to study the effect of the introduction of habits and aspirations on the intragenerational distribution of wealth. Our results show that the introduction of habits and aspirations has opposite effects on both the average amount of assets accumulated by individuals and the level of wealth inequality measured by the coefficient of variation of savings.

Concerning mobility of wealth within the same family, we find that the introduction of aspirations increases intergenerational mobility because the amount of bequests tends to be lower. However, the introduction of habits to preferences results in an increase in the autocorrelation between the amount of assets held by parents and children, because the amount bequeathed by individuals becomes more correlated with their wealth.

Our model is simple enough to obtain explicit characterizations of other policy experiments, such as the introduction of social security systems, and taxes on either capital income or consumption. The tax on consumption is especially relevant because it would directly affect the reference that individuals take into account when they evaluate their current consumption. Another potential extension of our model would be the introduction of either idiosyncratic or aggregate risks affecting the return on savings. This would create a source of volatility in the income of old individuals, giving rise to precautionary savings. How these savings would be affected by the presence of habits and aspirations is a topic for future research.

Appendix A

Proof of Lemma 1

To analyze the stability of the dynamic system formed by equations (16) and (17), determining the evolution of the average values of adult consumption and bequests in each period, we can rewrite the system in matrix form:

$$\begin{pmatrix} \bar{c}_t \\ \bar{b}_{t+1} \end{pmatrix} = \mathbb{P} \times \begin{pmatrix} \bar{c}_{t-1} \\ \bar{b}_t \end{pmatrix} + \begin{pmatrix} A\bar{w} \\ E\bar{w} \end{pmatrix}. \tag{A1}$$

Here, the coefficient matrix $\mathbb{P}$ is given by

$$\mathbb{P} = \begin{pmatrix} B & A \\ -F & E \end{pmatrix}.$$

Using the values of A, B, E, and F given in equation (13), we find that the coefficient matrix $\mathbb{P}$ appearing in equation (A1) has the determinant

$$\mathrm{Det}(\mathbb{P}) = \frac{R\delta\rho}{n(1+\beta+\rho)} > 0$$

and the trace

$$\mathrm{Tr}(\mathbb{P}) = \frac{\rho R + n\delta(\beta+\rho)}{n(1+\beta+\rho)} > 0.$$

The corresponding characteristic polynomial is

$$Q(\lambda) \equiv \lambda^2 - \left[\frac{\rho R + n\delta(\beta+\rho)}{n(1+\beta+\rho)}\right]\lambda + \frac{R\delta\rho}{n(1+\beta+\rho)}, \qquad \text{(A2)}$$

so that the values λ_1 and λ_2 solving $Q(\lambda) = 0$ are the eigenvalues of the coefficient matrix $\mathbb{P}$. The discriminant $\Delta(\delta)$ of the quadratic equation $Q(\lambda) = 0$ is

$$\Delta(\delta) = \frac{[\rho R + n\delta(\beta+\rho)]^2 - 4R\delta\rho n(1+\beta+\rho)}{n^2(1+\beta+\rho)^2}.$$

We can check that $\Delta(\delta) > 0$ if and only if

$$\delta \in \left\{0, \frac{\rho R}{n}\left[\frac{1-(1+\beta+\rho)^{1/2}}{\beta+\rho}\right]^2\right\}. \qquad \text{(A3)}$$

Let us assume for the remainder of this proof that δ lies on this interval, so that the two eigenvalues are real. We know that $\lambda_1 + \lambda_2 = \mathrm{Tr}(\mathbb{P}) > 0$ and $\lambda_1\lambda_2 = \mathrm{Det}(\mathbb{P}) > 0$. Therefore, because the two eigenvalues are real, their sign must be positive. Moreover, if δ tends to zero, the two eigenvalues converge to $\lambda_1 = \rho R/n(1+\beta+\rho) \in (0, 1)$ and $\lambda_2 = 0$, because the polynomial (A2) tends to $\lambda^2 - [\rho R/n(1+\beta+\rho)]\lambda$, and $\rho R/n(1+\beta+\rho) \in (0, 1)$ by assumption. Because the eigenvalues are continuous functions of δ representing the aspiration intensity, we conclude that, for a sufficiently small value of δ, both eigenvalues are real, positive, and smaller than 1, which proves the desired monotonic convergence property.

Proof of Lemma 2

First, we rewrite the dynamic system formed by equations (19), (20), and (21) in matrix form:

$$\begin{bmatrix} \mathrm{Var}(\mathrm{c_t}) \\ \mathrm{Var}(b_{t+1}) \\ \mathrm{Cov}(c_t, b_{t+1}) \end{bmatrix} = \mathbb{W} \times \begin{bmatrix} \mathrm{Var}(\mathrm{c_{t-1}}) \\ \mathrm{Var}(b_t) \\ \mathrm{Cov}(c_{t-1}, b_t) \end{bmatrix} + \begin{pmatrix} A^2\sigma^2 \\ E^2\sigma^2 \\ AE\sigma^2 \end{pmatrix}.$$

Here, the coefficient matrix $\mathbb{W}$ is given by

$$\mathbb{W} = \begin{pmatrix} B^2 & A^2 & 2AB \\ F^2 & E^2 & -2EF \\ -BF & AE & BE - AF \end{pmatrix}.$$

Using equation (13), we find that the characteristic polynomial of the matrix $\mathbb{W}$ is

$$T(\hat{\lambda}) \equiv \hat{\lambda}^3 - d\hat{\lambda}^2 + f\hat{\lambda} - g, \tag{A4}$$

with

$$d = \frac{\rho R[\rho R + n\delta(\beta + \rho - 1)] + n^2\delta^2(\beta + \rho)^2}{n^2(1 + \beta + \rho)^2},$$

$$f = \frac{\{\rho R[\rho R + n\delta(\beta + \rho - 1)] + n^2\delta^2(\beta + \rho)^2\}R\delta\rho}{n^3(1 + \beta + \rho)^3} = \left[\frac{R\rho\delta}{n(1 + \beta + \rho)}\right] d$$

and

$$g = \left[\frac{R\delta\rho}{n(1 + \beta + \rho)}\right]^3.$$

If δ approaches zero, then the three eigenvalues of the coefficient matrix $\mathbb{W}$ tend to $\hat{\lambda}_1 = [\rho R/n(1 + \beta + \rho)]^2 \in (0, 1)$, $\hat{\lambda}_2 = 0$, and $\hat{\lambda}_3 = 0$, because the coefficient d of the characteristic polynomial converges to $[\rho R/n(1 + \beta + \rho)]^2$, while the coefficients f and g tend to zero, and $\rho R/n(1 + \beta + \rho) \in (0, 1)$ by assumption. Therefore, the characteristic polynomial (A4) tends to $\hat{\lambda}^3 - [\rho R/n(1 + \beta + \rho)^2\hat{\lambda}^2$. Finally, because the eigenvalues are continuous functions of δ, it follows that the three eigenvalues will lie in the interior of the unit circle for a sufficiently small value of δ.

Proof of Lemma 3

To compute $\mathrm{Cov}(s^i_{t+1}, s^i_t)$, we use the functions (9), (11), and (12), making $a^i_t = c^i_{t-1}$ for all t. Then, the saving s^i_{t+1} of the direct descendent of the individual i belonging to generation t is

$$\begin{aligned} s^i_{t+1} &= Gw^i_{t+1} + Gb^i_{t+1} - Bc^i_t \\ &= Gw^i_{t+1} + G\underbrace{\left(Ew^i_t + Eb^i_t - Fc^i_{t-1}\right)}_{b^i_{t+1}} - B\underbrace{\left(Aw^i_t + Ab^i_t + Bc^i_{t-1}\right)}_{c^i_t} \\ &= Gw^i_{t+1} + (EG - AB)w^i_t + (EG - AB)b^i_t - (B^2 + FG)c^i_{t-1} \\ &= Gw^i_{t+1} + Hw^i_t + Hb^i_t - Ic^i_{t-1}, \end{aligned} \tag{A5}$$

where

$$H = EG - AB \quad \text{and} \quad I = B^2 + FG.$$

Using the fact that $a_t^i = c_{t-1}^i$, we can combine equation (12) with equation (A5), to obtain

$$\begin{aligned}\mathrm{Cov}\left(s_{t+1}^i, s_t^i\right) = {} & GH\sigma^2 + GH\mathrm{Var}(b_t^i) - GI\,\mathrm{Cov}\left(c_{t-1}^i, b_t^i\right) \\ & - BH\mathrm{Cov}\left(c_{t-1}^i, b_t^i\right) + BI\,\mathrm{Var}\left(c_{t-1}^i\right).\end{aligned}$$

Because wages w_t^i are cross-sectionally and serially i.i.d., the law of large numbers applied to our large economy implies that $\mathrm{Var}(b_t^i) = \mathrm{Var}(b_t)$, $\mathrm{Var}(c_{t-1}^i) = \mathrm{Var}(c_{t-1})$, and $\mathrm{Cov}(c_{t-1}^i, b_t^i) = \mathrm{Cov}(c_{t-1}, b_t)$. Thus, we immediately obtain the following empirical value of the covariance of savings between parents and their children:

$$\mathrm{Cov}(s_{t+1}, s_t) = GH[\sigma^2 + \mathrm{Var}(b_t)] + BI\,\mathrm{Var}(c_{t-1}) - (BH + GI)\mathrm{Cov}(c_{t-1}, b_t).$$

In Lemma 2, we have proved that, under the conditions appearing in the statement, $\mathrm{Var}(b_t)$, $\mathrm{Var}(c_t)$ (and thus $\mathrm{Var}(c_{t-1})$), and $\mathrm{Cov}(c_{t-1}, b_t)$ converge to $\mathrm{Var}(b)$, $\mathrm{Var}(c)$, and $\mathrm{Cov}(c, b')$, respectively. Therefore, $\mathrm{Cov}(s_{t+1}, s_t)$ converges to the expression $\mathrm{Cov}(s', s)$ given in equation (30).

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