ASSESSING THE EFFICIENCY OF PUBLIC EDUCATION AND PENSIONS.[1]

by

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Abstract

Theory says that in an OLG context intergenerational transfer agreements, either private or carried out via government intervention, are efficient if they induce equality between certain implicit rates of return. We apply this theory to the case of public education and pensions, where public education is interpreted as a loan from middle age to young, and pensions are the repayment of this loan, plus interest, from middle age to old. We use micro and macro data from Spain to estimate how far actual arrangements are from the normative goal. When demographic stationarity is assumed, efficiency appears reachable. But this is an illusion, due to neglect of demographic change. When this is accounted for, efficiency is far from being achieved. Our estimates point to dramatic changes in future generational rate of returns. Nevertheless, and contrary to earlier predictions in the generational accounting literature, our findings suggest that future generations may not necessarily be worse off than current ones.

1. Introduction

Moral hazard problems have long prevented and still prevent the development of credit markets to finance individual investment in human capital. It is often alleged that this is the main reason for the existence of public education financing. The argument is intuitively convincing: to the extent that human capital accumulation is both necessary for growth and a gateway to a more efficient allocation of resources, government intervention can ameliorate such a far-reaching and widespread market failure. In Boldrin and Montes (1999, 2005) we cast this argument in the context of a life-cycle model of saving and human capital accumulation and reach the following conclusion: public education per-se, even if provided in the "efficient" amount, is not enough to restore efficiency when credit markets to finance human capital accumulation are missing. This is because, when a general equilibrium perspective is adopted, one is lead to recognize that financing the accumulation of human capital is just a part of the general life-cycle saving and consumption problem. During their working years, individuals invest in various assets to provide for retirement consumption; if financial markets were complete the human capital of future generations would be a component of the optimal retirement portfolio. The optimal retirement portfolio allows you to invest in the human capital of the future generations and, later on, also to draw a return from such investment. Public education achieves the first objective, i.e. it allows the working generation to invest in the human capital of the future generations, but not the second, i.e. it does not allow the former investors to collect the market return from their beneficiaries. This, we have shown, will generally lead to an inefficiency: investment in physical capital is too high and there is less intergenerational consumption smoothing than under the first best.

Our proposed solution is to link public financing of education and public pensions. This leads to a completely different design of PAYGO pension systems from the one advocated in Diamond (1965). In a life-cycle model, through the public financing of education, the young borrow from the middle age to invest in human capital. When middle age and employed, they pay back their debt via a social security tax, the proceedings of which finance pension payments to the now elderly lenders. In this setting public financing of education and public pensions are parts of a "social contrivance" between generations: if pension payments are appropriately linked to earlier investment in human capital, the complete market allocation can be achieved and, should the latter be implemented, a certain equality among (risk adjusted) rates of return should be observed.

In section 2 we illustrate this point by means of an example, which extends the model developed in Boldrin and Montes (2005) to take into consideration the optimal welfare policy response to demographic shocks. In the rest of the paper we take the normative prescriptions of our model to the data. By doing so, we are not pretending to test the model, as the latter has only normative implications; we are instead pretending to test the efficiency of a specific public education and pension system, the Spanish one and, more important, to begin assessing quantitatively its ability to handle demographic shocks. We use data from Spain to get a quantitative assessment of how far current arrangements are from the theoretical optimum and how the foreseable demographic evolution of the next fifty years will impact generational welfare and the system's efficiency.

The results are surprising along more than one dimension. On the one hand, under the assumption of demographic stationarity, current arrangements come extremely close to satisfy the predicted equality of rates of return. According to our criterion, this means both that the efficient allocation is being approximated and that a negligible amount of intergenerational redistribution is taking place. To test the robustness of this finding, we also simulate a number of reasonable future demographic and policy scenarios. Things change dramatically. We find that, should current rules be maintained, the combined Spanish education and pension system will grossly violate the desired rate of return equality and, therefore, become both inefficient and highly redistributive across generations. In other words, the existing Spanish welfare system - likewise, we suspect, those of most advanced countries - would do decently, in terms of aggregate efficiency, in a stationary world, but performs terribly and unpredictably in front of demographic change.

While not theoretically surprising (the intellectual foundations of the system assume complete stationarity along every dimension) this is most relevant from the point of view of practical policy. Our welfare systems need to be re-designed and reformed not just in their parameters (a few more years before retirement, a little bit of additional education fees, a less generous replacement ratio) but in their inner structure and basic assumptions. The computed rates of return are far enough from efficiency to suggest that reforming the two systems by making the linkage between education and pensions explicit could improve social welfare substantially. Similar, or even stronger, conclusions are likely to hold for other European countries. This is our contribution to the ongoing policy debate on reforming the welfare state.

Further, in the applied literature on contribution-based Social Security systems the issue of actuarial fairness between contributions paid and pensions received is an actively debated topic. Our model suggests that one should look for actuarial fairness somewhere else, that is between contributions paid and amount of public funding for education received on the one hand, and between taxes devoted to human capital accumulation and pension payments on the other. This observation is not irrelevant for the debate about the "sustainability" of public pension systems in USA and Europe alike.

The spirit of the empirical exercise is affine, but not identical, to that of the literature on Generational Accounting (see, for example, Auerbach, Kotlikoff, and Leibfritz (1999) and references to earlier work therein), which asks how far away from intergenerational balance current fiscal policies are. Instead, we ask how far away from the normative optimum current public education and pension systems are. Further, they calculate the present value of the amount a typical member of each generation can expect to pay in taxes net of transfer payment received. In our simulations, instead, we assume that the education and pension budgets are balanced yearly and compute the (implicit) rates of interest and of return for the typical member of each generation. In this sense, given the demographic predictions, we compute which policies would keep the overall system close to the normative optimum and which would lead it far astray, which would redistribute in favor of some generations and which would sustain intergenerational neutrality. Traditionally, works in the GA tradition have treated education as government consumption, leaving aside its role as an investment/transfer favoring the young generations. More recent works have modified this assumption and started treating public education as a transfer toward the young. This modification is, in our view, quite appropriate and has lead to empirical findings that go in a direction similar to ours, i.e. a lower burden of taxation on the young and future generations.

Our approach is therefore complementary and not alternative to Generational Accounting, and it may lead to a clearer theoretical understanding of the empirical estimations obtained with that methodology. When looking at the whole collection of public policies and associated taxes, though, it remains a daunting task to model appropriately the "missing markets" these policies are supposed to take care of. The case for education and pensions is, in our view, much clearer and well defined than that for most other welfare policies.

2. Normative Theory

To illustrate our argument, consider an economy of overlapping generations where three generations are present in each period $t = 0, 1, 2, \cdots$. The aggregate physical capital, K_t, and the aggregate human capital, H_t, are owned, respectively, by the old and the middle age individuals. Aggregate output of the homogenous commodity is $Y_t = AK_t^{\alpha} H_t^{1-\alpha}$, with $A \geq 1$ and $\alpha \in (0, 1)$. At the beginning of each period t a new generation of young agents is born (called generation t) which it is of size $N_t = N_{t-1}(1 + n_t)$. Each member of generation t is endowed with a stock h_t^y of basic knowledge which can be used to produce human capital. If she spends time and money at school her human capital becomes $h_{t+1} = Bd_t^{\beta}(h_t^y)^{1-\beta}$, with $B \geq 1$, $\beta \in (0, 1)$, when middle age. Here, d_t is the amount of homogenous good invested in the educational process. During the second period of their life, individuals work and carry out consumption-saving decision. When old, they consume the total return on their saving before dying.

We assume agents draw utility from consumption when middle age and old (c_t^m and c_{t+1}^o) according to the utility function $log(c_t^m) + \delta log(c_{t+1}^o)$. Neither leisure nor the welfare of their descendants affect utility.

Let the homogenous commodity be the numeraire. In each period $t = 0, 1, 2, \cdots$ aggregate output Y_t is allocated to three purposes: aggregate consumption ($C_t = c_t^m N_{t-1} + c_t^o N_{t-2}$), accumulation of next period's physical capital (K_{t+1}) and aggregate investment in education ($D_t = d_t N_t$). Human and physical capital are hired by firms at competitive prices equal, respectively, to $w_t = A(1-\alpha)K_t^{\alpha}\ H_t^{-\alpha}$ and $1 + r_t = A\ \alpha K_t^{\alpha-1} H_t^{1-\alpha}$. Aggregate saving ($S_t = s_t N_{t-1}$) is allocated, through competitive credit markets, to finance physical and human capital accumulation ($S_t = K_{t+1} + D_t$), accruing a total return equal to $(1 + r_{t+1})S_t = R_{t+1}S_t$.

Assume financial markets for both kinds of capital are available. In these circumstances, the life-cycle optimization problem for an agent born in period $t - 1$ is

$$U_{t-1} = \max_{d_{t-1}, s_t} \left\{ \log(c_t^m) + \delta \log(c_{t+1}^o) \right\} \tag{2.1}$$

subject to:

$$
\begin{aligned}
&0 \le d_{t-1} \le \frac{w_t h_t}{R_t} \\
&c_t^m + s_t + R_t d_{t-1} \le w_t h_t \\
&c_{t+1}^o \le R_{t+1} s_t \\
&h_t = B d_{t-1}^{\beta} \left(h_{t-1}^{y}\right)^{1-\beta}.
\end{aligned}
$$

The first order conditions give

$$
s_t = \frac{\delta}{1+\delta}\left[w_t h_t - (1+r_t) d_{t-1}\right],
$$

$$
d_{t-1} = \beta \frac{w_t h_t}{(1+r_t)}.
$$

Competitive firms maximize profits given factor prices, using their first order conditions:

$$
\begin{aligned}
s_t &= \frac{\delta}{1+\delta}(1-\alpha)(1-\beta)\frac{A K_t^{\alpha} H_t^{1-\alpha}}{N_{t-1}} \\
d_{t-1} &= \frac{\beta(1-\alpha)}{\beta}\frac{K_t}{N_{t-1}}
\end{aligned}
$$

Setting $\beta(1-\alpha)/\alpha = \gamma$ and using the market-clearing condition for saving and investment, gives

$$
s_t N_{t-1} = (1+\gamma) K_{t+1}
$$

and

$$
d_{t-1} = \frac{\gamma}{(1+\gamma)} \frac{s_{t-1}}{(1+n_{t-1})}.
$$

Aggregate saving is therefore equal to

$$
S_t = \left[A \frac{\delta(1-\alpha)(1-\beta)}{1+\delta}\right] K_t^{\alpha} H_t^{1-\alpha},
$$

and aggregate education is

$$
D_{t-1} = \frac{\gamma}{(1+\gamma)} \left[A \frac{\delta(1-\alpha)(1-\beta)}{1+\delta}\right] K_{t-1}^{\alpha} H_{t-1}^{1-\alpha}
$$

which implies

$$K_{t+1} = A\eta K_t^{\alpha} H_t^{1-\alpha} \tag{2.2a}$$

$$H_{t+1} = B(h_t^y N_t)^{1-\beta} \left[\gamma A\eta K_t^{\alpha} H_t^{1-\alpha}\right]^{\beta} \tag{2.2b}$$

where $0 < \eta = \frac{\delta}{(1+\delta)} \frac{(1-\alpha)(1-\beta)}{(1+\gamma)} < 1$.

Set $h_t^y = H_t/N_t$ so that an autonomous system can be derived. The only rest point of (2.2) is the origin. The ray

$$X^* = \frac{K_t}{H_t} = \left[\frac{A\eta}{B\left(A\gamma\eta\right)^{\beta}}\right]^{\frac{1}{1-\alpha(1-\beta)}}$$

in the (H_t, K_t) plane defines a balanced growth path. Straightforward algebra shows that for all initial conditions $(H_0, K_0) \in \Re_+^2$, iteration of (2.2) leads (H_t, K_t) to the ray X^*. Along the balanced growth path, the two stocks of capital expand (or contract) at the factor

$$1 + g^* = A\eta \left[\frac{B(A\gamma\eta)^{\beta}}{A\eta}\right]^{\frac{1-\alpha}{1-\alpha(1-\beta)}}$$

which is larger than one (i.e. there is unbounded growth) when

$$\eta > \frac{1}{A} \cdot \left[\frac{1}{B^{1/\beta}\gamma}\right]^{(1-\alpha)}.$$

A sufficient condition for the equilibrium path to be dynamically efficient is that the gross rate of return on capital be larger than or equal to one plus the growth rate of output. With linearly homogeneous production functions, the rate of return on capital is determined by the factor intensity ratio. Hence we need $(1 + g^*) < \alpha A \left(X^*\right)^{-(1-\alpha)}$. The latter reduces to $\alpha > \eta$, which is equivalent to

$$\frac{(1-\alpha)(1-\beta)}{\alpha + \beta(1-\alpha)} < \frac{1+\delta}{\delta}.$$

For reasonable values of α and β, the latter is satisfied, as long as $\delta > 0$.

Next, consider a situation in which markets for financing education are altogether absent. Then $d_t = 0$ and $s_t N_{t-1} = K_{t+1}$ for all t. The competitive equilibrium is not efficient. Introduce the intergenerational welfare state. In each period t two taxes are levied upon the middle age generation, to provide resources for two simultaneous transfers. The proceeding from the first tax (T_t^p) are used to pay out a pension (P_t) to the elderly. The proceeding from the second tax (T_t^e) are used to finance investment in the education (E_t) of the young generation. We assume balanced budget period by period, *i.e.*

$$\underbrace{e_t N_t}_{E_t} = \underbrace{t_t^e N_{t-1}}_{T^e{}_t} \quad \text{and} \quad \underbrace{t_t^p N_{t-1}}_{T_t^p} = \underbrace{p_t N_{t-2}}_{P_t},$$

where e_t denotes the per young benefit from the education system, t_t^e and t_t^p are the per capita contributions to the education and the pension system respectively, and p_t denotes the per capita benefit from the pension system.

The budget constraints for the representative member of a generation born in period $t-1$ become

$$0 \leq d_{t-1} \leq e_{t-1} \tag{2.3a}$$

$$c_t^m + s_t \leq w_t h_t - t_t^p - t_t^e \tag{2.3b}$$

$$c_{t+1}^o \leq R_{t+1} s_t + p_{t+1}. \tag{2.3c}$$

Comparing equations (2.3) to the budget restrictions of problem (2.1) shows that, if the aggregate lump-sum amounts satisfy

$$E_t = D_t^* \qquad \text{and} \qquad P_t = D_{t-1}^* R_t^*, \tag{2.4}$$

the competitive equilibrium under the new policy achieves the Complete Market Allocation (starred symbols, from now onward, refer to the CMA). In other words, a benevolent planner can restore efficiency, improve long-run growth rates, and preserve intergenerational fairness by establishing publicly financed education *and* PAYGO pensions simultaneously, and by linking the two flows of payments via the market interest rate.

Only this arrangement can implement the efficient complete market allocation. Note first that neither retirement pensions financed by the investment in physical capital nor a PAYGO system with a rate of return equal to the growth rate of the population can achieve the CMA. Second, a system of pure public school financing cannot lead to the CMA either. Only a *combined* public education and pension system satisfying (2.4) can restore the CMA. This scheme is also intergenerationally "fair", in the sense that it provides each generation with a market driven return from its investment in human capital. In particular, we have

$$E_t i^*_{t+1} = T^p_{t+1}, \qquad T^e_t \pi^*_{t+1} = P_{t+1} \qquad \text{and} \qquad i^*_{t+1} = \pi^*_{t+1} = R^*_{t+1}. \tag{2.5}$$

Note that, contrary to what seems to have become the norm in many European reforms (e.g. Italy and Sweden) the internal rate of return of an efficient PAYGO pension system should not be determined by the growth rate of GDP but, instead, by the rate of return on human capital investment.

Note also that balanced budget in each system imply

$$e_t N_t = t^e_t N_{t-1} = D^*_t \qquad \text{and} \qquad t^p_t N_{t-1} = p_t N_{t-2} = D^*_{t-1} R^*_t,$$

The optimal welfare policy must take changes in cohorts size into account to maintain efficiency and intergenerational fairness. This is clarified in the next subsection.

2.1. Fertility Shocks

Assume that in period t there is a temporary negative fertility shock, reflecting a baby bust in period t. To simplify we assume the shock has no effects on the size of the population born in $t+1$. This can be expressed as $n_{t+j} = n \ \forall j \neq 0, 1$, $n_t = \widetilde{n}_t < n$ and $1 + n_{t+1} = (1+n)^2 / (1 + \widetilde{n}_t)$. We ask what the optimal policy response is. The demographic shock is fully predictable at the beggining of period t.

If we keep per capita investment in education constant, then $E_t = d^*_t (1 + \widetilde{n}_t) N_{t-1} < D^*_t = d^*_t (1+n) N_{t-1}$. When $E_t < D^*_t$, the solution to the consumer problem violates the social optimum (CMA) first order condition, as $F_2(H_{t+1}, K_{t+1}) = R_{t+1} < w_{t+1} h_1(d^*_t, h^y_t)$ holds instead. Too much is invested in the physical capital stock, the K/H ratio is too high, and the rate of return on capital is too low respect to the efficient one. To restore efficiency we need to increase the amount invested in each young individual until it reaches $\widetilde{d}_t = d^*_t (1+n) / (1 + \widetilde{n}_t)$. By doing this the planner reaches $E_t = D^*_t$ and $R^*_{t+1} = w_{t+1} h_1(\widetilde{d}_t, h^y_t)$.

Next we notice that this is not enough to restore efficiency at $t+1$, for two reasons. First, if each member of generation t pays the same social security contributions as before, $t^p_{t+1} = d^*_t R^*_{t+1} < \widetilde{d}_t R^*_{t+1}$ holds. This means that the net labor income in period $t+1$ is too much and the capital income in $t+1$, $s_t R_{t+1}$, is too little relative to the efficient ones. This leads to "too munch" investment and “too little” consumption for individuals that are old during $t+1$. In other words, parents of the generation born in t face $i_{t+1} < r^*_{t+1}$ and $\pi_{t+1} < r^*_{t+1}$ and are therefore "subsidizing" their children relative to the social optimum. To restore efficiency the members of the baby-bust generation must pay back their debt in full. This holds when $\widetilde{t^p}_{t+1} = (1+n)/(1+\widetilde{n}_t)\, d^*_t R^*_{t+1} > d^*_t R^*_{t+1} = t^{p*}_{t+1}$, yielding $i^*_{t+1} = \pi^*_{t+1} = r^*_{t+1}$.

Second, if the demographic shock hits only in period t, the optimal investment in education in period $t+1$ $\left(D^*_{t+1}\right)$ requires $\widetilde{t^e}_{t+1} = (1+n)/(1+\widetilde{n}_t)\, t^{e*}_{t+1}$. This, in turns, affects the optimal pension payment in period $t+2$, which must equal $\widetilde{p}_{t+2} = (1+n)/(1+\widetilde{n}_t)\, t^{e*}_{t+1} R^*_{t+1}$. Again, this yields $i^*_{t+2} = \pi^*_{t+2} = r^*_{t+2}$, and the efficient allocation is restored. Note that the optimal policy response to a temporary baby bust in t lasts until period $t+2$ even under the assumption that fertility moves back to its stationary level after just one period.

Similarly, we can compute the optimal policy response to a baby boom in period t . This requires reducing per capita taxes $\left(t^p_{t+1}, t^e_{t+1}\right)$ and transfers (e_t, p_{t+2}) by the factor $(1+n)/(1+\widetilde{n}_t)$. In both cases the optimal policy must compensate for demographic shocks; when this is not done both aggregate inefficiency and redistribution arise.

2.2. Assessing the Distance from the Normative Optimum

It follows from this discussion that if all the implicit rates of return can be estimated, their deviations from the market rate of return on investments with a degree of risk comparable to education would provide a reasonable measure of the distance from the social optimum.

These considerations lead us to entertain, albeit briefly, a positive reading of our model. In the real world benevolent planners are probably harder to come across than credit instruments for financing education. A priori, there are very few reasons to expect that existing public education and pension systems should strive to replicate the complete market allocation and achieve the efficiency gains we have outlined here. As a matter of fact, in none of the countries we are aware of is the welfare state legislation explicitly organized around the principles advocated in this paper. In general, social security contributions are levied as a percentage of labour income and bear no clear relation to the previous use of public education. Pension benefits received are related, in one form or another, to past social security contributions but never to some measure of lifetime contributions to aggregate human capital accumulation. Still, there are intuitive reasons to believe that intergenerational transfers that are either grossly inefficient or openly unfair (in the sense that some generations collect rates of return systematically higher than those of other generations) would be subject to strong public pressure to be either dismantled or improved upon. Further, in a recursive environment in which the middle-age generation decides whether and how to implement an intergenerational welfare system, an equilibrium satisfying (2.5) may arise. In Boldrin and Montes (1999) we present a dynamic game of generational voting, along the lines of Boldrin and Rustichini (2000), which possesses a subgame perfect equilibrium implementing the CMA. We refer the interested reader to Boldrin and Montes (2006a) for this result, a discussion of the circumstances under which the political equilibrium implementing the CMA is the unique subgame perfect and, finally, for extensions to other notions of recursive equilibrium, and to more general OLG environments. Results along the same lines have been derived independently by Rangel (2003) and, to a smaller degree, by Bellettini and Berti-Cerroni (1999), while Cigno (2004) contains a fairly complete survey of theoretical results on efficient intergenerational transfers, especially in their connection to fertility choice.

All of this conjures to make an examination of the data worthy of our time. This we do, using Spanish data, in the next section.

3. The Spanish Intergenerational Welfare State

In this section, we use Spanish data to compute the values of i and π implied by the rules in place and the taxes and transfers implemented between 1990-1991 and 1998-1999. To carry out our computations, the stationarity assumptions made in the model are first taken verbatim and then relaxed. We proceed in two stages. In the first, we abstract from demographic change and assume constant growth, the latter being a reasonable approximation given available evidence. In the second stage, we incorporate the forecasted demographic evolution for the period 1998-2089 and consider how a number of policy scenarios fare in this context.

More specifically, in our empirical exercise we assume that the rules of the Spanish public education and public pension systems will not be changed for the very long future and that all individuals currently alive have also lived under those same rules in the past. This is obviously false, because both education and pension systems underwent large and frequent changes in the period 1960-85. In 1985 the pension system was reformed once more, and since then, it has kept its basic rules almost unchanged. The same goes for the public education system, which achieved its current structure in the early 1980s and has not changed much since. Hence, while our assumption of stationarity is only an approximation to reality, it is a good approximation for the last 20 years, and it appears to be a reasonable one for the foreseeable future.

In the first stage, we assume that the aggregate burden of taxation and its age distribution have not varied and will not vary over the lifetime of the individuals alive during 1990-1999. In both cases we let age-specific per capita income grow at a constant rate and adjust aggregate taxation accordingly, under the assumption of a constant age distribution of taxes and transfers. Notice that, if it were not for the changing demographic structure, this would imply constant tax and transfer rates for each age group and function. Finally, in all of our simulations we make the assumption that the education and pension yearly budgets are balanced.

We abstract from deficit financing and the generational burden of public debt for a variety of reasons. First, the Spanish public sector deficit has varied a lot during the last 15 years and has decreased to values very near zero since 1998. The same is true for the social security administration budget, which was repeatedly manipulated by changes in accounting criteria and has generated a surplus since 1997. Secondly, there is no reliable method to allocate the debt burden over different cohorts, either for the past or for the future. Third, no ear-marking of debt is available, hence any attribution of part of the current or future debt to either education or pensions would be completely arbitrary. The intergenerational distribution of the debt burden remains, nevertheless, an important issue to be addressed. It requires an explicit model of optimal fiscal policy in a life cycle model with changing demographic structure. A first step in this direction is taken in Boldrin and Montes (2006b).

Ours are, indeed, relatively strong assumptions. Stationarity and balanced growth assumptions are often made in most empirical applications of dynamic models, and our case makes no exception. Given the available micro data, we find our approach to be a reasonable starting point.

3.1. The base case under demographic stationarity

Consider an individual living for a maximum of A periods, and let p_a denote the (conditional) probability of survival between age a and $a+1$. Denote with i the interest rate at which young people “borrow” through public education and with π the rate of return the elderly receive from their “investment” in public education. For a given sequence of taxes and transfers, the rates i and π (time invariant, because of the stationarity assumptions) are defined implicitly by[4]

$$\sum_{a=1}^{A} \Pi_{j=1}^{a} p_j \cdot (1+i)^{A-a} \left[E_a - T_a^p \right] = 0 \tag{3.1a}$$

$$\sum_{a=1}^{A} \Pi_{j=1}^{a} p_j \cdot (1+\pi)^{A-a} \left[T_a^e - P_a \right] = 0. \tag{3.1b}$$

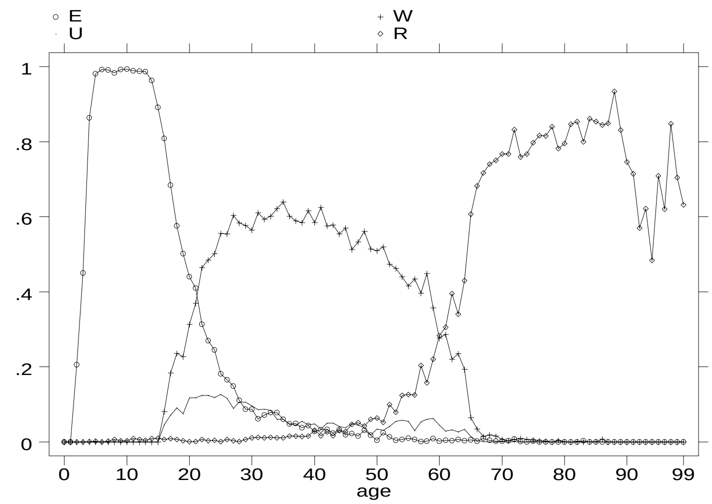
To compute the stationary values of i and π, we use several kinds of micro and macro data[5]. The choice of the reference years for the baseline case is dictated by the availability of data, especially for what is concerned with the allocation of time along the life cycle. Currently, there is only one reliable data source, the *Encuesta de Presupuestos Familiares*, Household Budget Survey or EPF from now on, which is furthermore available only for 1980-1981 and 1990-1991. We have used the 1990-1991 EPF because the Spanish public pension system underwent a major reform in 1985 and because the 1980-1981 EPF contains only a severely limited subset of the information we need.

For each individual in the sample, conditional upon age and occupational status, the information in the EPF allows for the estimation of (1) the value of the school services received and which were directly or indirectly financed by the state, (2) the value of direct and indirect taxes paid, (3) the amount of pension contributions paid, and (4) the amount of public contributive pensions received. The information in the EPF also affords the computation of the share of the population which, at each age, is studying, working, unemployed, or retired. Such lifetime distribution of activities is reported for 1990-1991, in percentages of each age group, in Figure 1.

Figure 1: Life-time distribution among activities.

[4] The equations (3.1) are the extensions of the equations (2.5) to the case of an individual that live for A periods.

[5] Further details about the data sets we use are in the Appendix and in Montes (2000).



E=Student, W=Worker, U=Unemployed, R=Retired, Inactive, not reported.

The representative agent for our base case related to years 1990/91 is defined by the following assumptions:

(a) At age $a = 1, \ldots, 99$, the probability p_a of being alive at age $a+1$ is the one reported by the *Instituto Nacional de Estadistica* for that age group in 1998. The EPF does not contain individuals older than 99.

(b) At each age $a = 1, \ldots, 99$, the representative individual is working, studying, unemployed, or retired with a probability equal to the frequency of that activity in the EPF sample of people of age a.

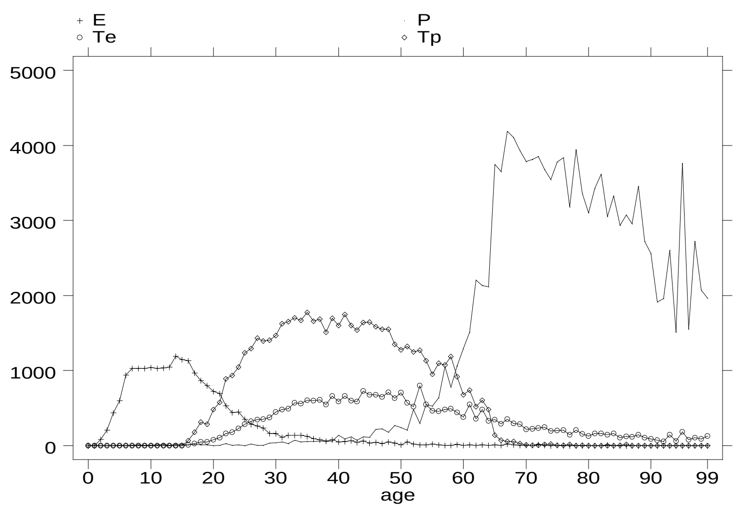
(c) At each age $a = 1, \ldots, 99$, an individual receives or pays transfer and taxes equal to the average, in the EPF, for those individuals that at age a were in the same occupational status.

Assumptions (a)-(c) can be used to extract from the EPF the amounts E_a, P_a, T_a^e, and T_a^p that an individual of age a would pay or receive. Such estimation uses the age- and status-specific information contained in the EPF, according to assumptions (b) and (c). Let X be a stand-in for any of the four quantities. For each $a = 1, 2, \ldots, 99$, we use population data to compute the amounts X_a attributable to the representative agent of that age. Let L_a be the number of individuals of age a in the Spanish population in the year 1990 (INE (1991)). A four-tuple of weights x_a can be computed by setting

$$x_a = \frac{X_a}{\sum_{a=1}^{A} X_a L_a}.$$

Write this four-tuple of x_a as $[\alpha_a, \beta_a, \gamma_a, \delta_a]$. The terms denote, respectively, the share of total T^e and T^p paid and of total P and E received (according to the EPF) by the representative individual of age a. Next, from the government and social security administration budgets for 1990, we compute the quantities X^{90} corresponding to the effective total tax or transfer relative to each function. We allocate these amounts over the lifecycle of the representative agent by means of the weights x_a. The lifetime distribution of these four flows, in Euros of 1990, is reported in Figure 2.

Figure 2: Life-time distribution of tax and transfer flows (1990)



Back to our computations. Equations (3.1) can then be rewritten as

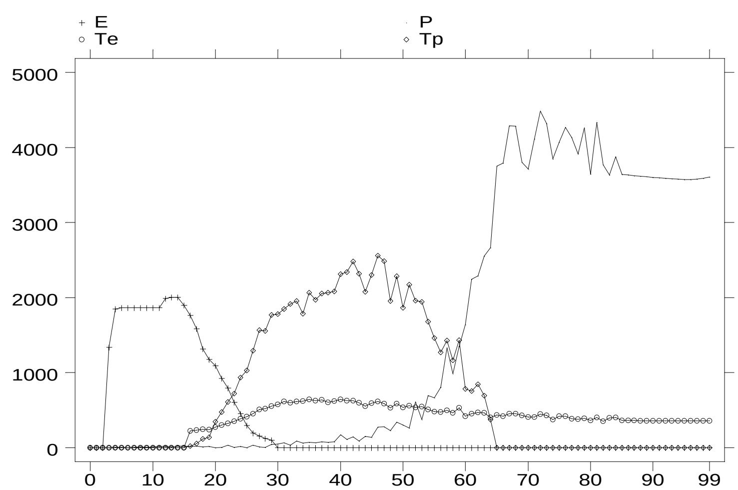
$$\sum_{a=1}^{99} \left(\Pi_{j=1}^{a} p_j\right) (1+i)^{99-a} \left[\delta_a \cdot E^{90} - \beta_a \cdot T^{90,p}\right] = 0 \tag{3.2a}$$

$$\sum_{a=1}^{99} \left(\Pi_{j=1}^{a} p_j\right) (1+\pi)^{99-a} \left[\alpha_a \cdot T^{90,e} - \gamma_a \cdot P^{90}\right] = 0. \tag{3.2b}$$

To exploit all the information available to us, we have also made an effort to incorporate more recent data for the years 1998-1999. This data set, provided by Collado *et al.* (2004), is less complete than the 1990-1991 EPF as it reports substantially less micro information at the household level. Nevertheless, they provide enough information about the age-distribution of social security contributions, total taxation, education transfers and pensions payments during 1998-1999 to make our approach implementable. For what is concerned with pension payments and direct taxation, the new data is basically extracted from the 1998 wave of the European Community Household Panel Survey, whilst to derive education profile they combine per capita expenditure by level of education (from the Spanish Ministry of Education) with enrollment rates (provided by the OECD). To obtain indirect taxes at the individual level they use the EPF data from 1990-91, as we do.

Using this more recent data in conjunction with updated population estimates, reported in INE (1999), we compute the new four-tuple of x_a (*i.e.* $[\alpha_a, \beta_a, \gamma_a, \delta_a]$.) Then, we go to the government and social security administration budgets for 1998 to compute the aggregate quantities X^{98} corresponding to the effective total tax or transfer for each function. Next, we allocate these amounts over the lifecycle of the representative agent by means of the weights x_a. The new lifetime distributions of the four flows, in 1990 Euros, are reported in Figure 3.

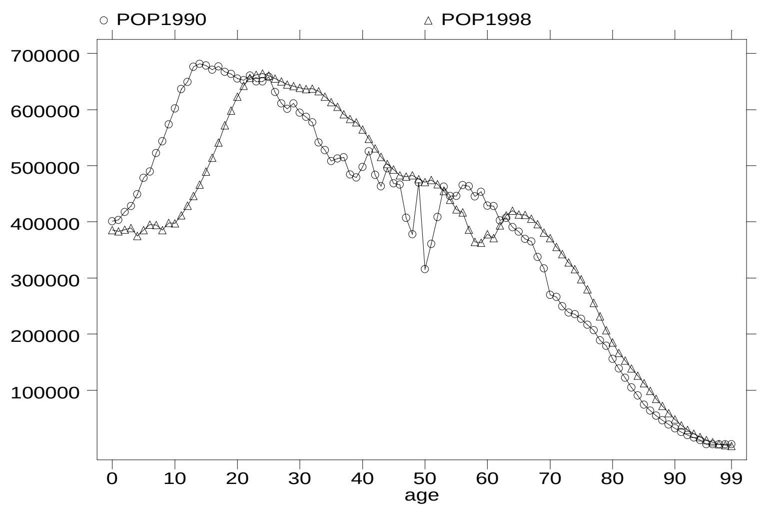
Figure 3: Life-time distribution of tax and transfer flows (1998)



A comparison with Figure 2 shows the substantial increase in the amount of public education transfers, which have literally doubled in real value at almost all age groups between 6 and 25. This is due to both strong enrollment growth and an increase in per capita expenditure. Pension expenditure has remained roughly unchanged while the increase in employment rate has brought about a visible increase in social security contributions.

A rough idea of the demographic change that took place during the decade may be obtained from Figure 4. The young age dependence ratio has decreased of 26%, while the old age dependence ratio has increased of 15,8%.

Figure 4: Change in population: 1990-1998.



Finally, we use the age-specific values obtained from the information in the two base years (1990-91 and 1998-99) to impute taxes and transfers to each generation living during the nineties. To avoid burdening the reader with too many numbers, we focus on three cohorts that are fairly representative of the different generations involved in our exercise, i.e. the cohorts born in 1950, 1974 and 1990 respectively. Think of them as the "old", "middle age" and "young" Spaniards of 2006. For the individuals born in 1950 and in 1974 we use 1990-91 (1998-99) age-specific values to impute the taxes/transfers paid/received in the years previous to 1990 (after 1998). For the cohort born in 1990 and for all the individuals of the other two cohorts that were alive between 1990-91 and 1998-99 we compute the taxes/transfers paid/received during the years 1991-1998 by taking a convex combination, with time-varying weights of the data from 1990-91 and 1998-99. Specifically, let $t = 0$ correspond to 1990 and $t = 9$ corresponds to 1999. Then, in year t the age-specific tax/transfers used are computed as

$$(1 - \lambda_t) \left[x_a(90/91) \cdot X^{90} \right] + \lambda_t \left[x_a(98/99) \cdot X^{98} \right]$$

where $\lambda_t = t/9$ for $t = 0, ..., 9$.

For our base case, under demographic stationarity, we use the new taxes/transfers paid/received along the life cycle of the representative agent of each cohort to solve the expressions (3.1) numerically. Using the mortality rates reported by INE for 1998 and a balanced growth rate of 3%, a value quite closed to the growth rate of Spanish GDP since the early 1990s, our point estimates[6] are, respectively,

Cohort 1990

$$i = 6.17\%; \pi = 6.59\%$$

Cohort 1974

$$i = 7.35\%; \pi = 6.90\%$$

Cohort 1950

$$i = 7.56\%; \pi = 6.89\%$$

We interpret these estimates as follows: *under the assumption of demographic stationarity, the combined education and pension system in Spain would have been not very far from the social optimum for the cohorts born roughly between 1950 and 1990. More specifically, the data suggest that, given the amount of educational transfers received, social security contributions are a bit "too low" and/or that, given the amount of taxes invested in the education of the young, pension payments are "too high" for the most recent generation, while the opposite was true for the two older ones..*

We move next to the case of demographic non-stationarity.

4. Welfare Policies in a Non-Stationary Spain

4.1. Changes in Mortality Rates

In the previous calculations we have used the mortality rates reported by INE for 1998 (assumption (a) above). The life expectancy has increased since then and is widely believed to continue increasing during the forthcoming decades. To correct for this, we run the base case simulation again using the updated survival

[6] Our estimate of i depends upon the convention with which one handles the yearly surpluses and deficits of the various Spanish social security administrations. Also, we assume that pensions also grow at 3% per year during the working life, and become constant at age 65. Final results do not vary substantially, and details are available from the authors upon request.

probabilities implicit in the Fernández Cordón (2000) demographic forecasts.[7] The new estimated rates are

Cohort 1990

$$i = 6.28\%; \pi = 7.02\%$$

Cohort 1974

$$i = 7.44\%; \pi = 7.24\%$$

Cohort 1950

$$i = 7.64\%; \pi = 7.17\%$$

Somewhat un-expectedly, the increasing life expectancy does not affect the older cohort in any substantive way, while it begins to substantially break down the equality of rates of return for the younger cohorts.

4.2. Demographic Change

Changing the demographic structure while keeping the balanced budget requirement satisfied in each period requires making assumptions on the policies for distributing the additional taxes and transfers across individuals belonging to different generations. In particular, one needs to make an assumption as to which features of the system that were observable in 1990-1991 and 1998-1999 will be maintained in future periods. Many scenarios are conceivable. We selected two hypothetical scenarios, which we consider most informative.

We are interested in two of effects of a policy. First, we want to compute the impact on aggregate efficiency, a good measure of which is the distance between the implicit rates of return and the market interest rate. Second, we want to measure the impact on intergenerational redistribution, which is captured by the distance between lending and borrowing rate for each cohort. In all scenarios, we use the values from the baseline case to impute the taxes/transfers paid/received in the years previous to 1998.

- Scenario A, we assume that age-specific per capita expenditures in education and pension will remain at their 1990-1998 level, in real terms.

[7] The population forecasts of Fernández Cordón (2000) are obtained by simultaneously using new mortality rates and expected immigration flows. Unfortunately, the two sources of change cannot be disentangled, so that for certain age groups the estimated probability of survival is slightly higher than one. Immigrants are concentrated in the 20 to 40 age groups and we corrected the forecasts for this effect, to the extent possible.

- Scenario B, we assume that age-specific, per capita education taxes and social security contributions will remain at their base case values.

The careful reader will notice that, in both scenarios, the specific policy adopted and the year-by-year balanced budgets are not enough, for given demographics, to uniquely pin down all remaining variables. Consider, for example, Scenario A. Using per capita expenditure in education and demographic data, we can compute total education expenditure E_t in each future year. The balanced budget constraint implies that $E_t = T_t^e$, for all t. This determines the total education tax to be levied in each year, but leaves its distribution, across generations, still open. The same is true for the distribution of T_t^p across generations, and so on. To address this problem, we proceed as follows. For each flow, let X_a be the amount paid or received by the representative individual of age a according to the 1990-98 data. For each $x = E, T^e, P, T^p$ and age $a, a' = 1, 2, \ldots, A$, define the constants

$$k^x(a, a') = \frac{X_a}{X_{a'}}.$$

Then, for all future years and in both scenarios we assume that, for each function x whose distribution over cohorts is to be determined endogenously, the payments from or transfers to the average individuals of age a and a' will yield the same $k^x(a, a')$ as in the base case under demographic stationarity. In other words, we assume that, while a certain policy may either favor or hurt a given cohort over its entire lifetime, it will not do so by charging different taxes to people of different ages in any given year. The same is true for transfers.

Scenario A We set real per capita expenditure E_a and P_a at the base case level, for all a. The demographic projections allow the computation of aggregate expenditures, E_t and P_t, for each year $t = 1998, \ldots, 2089$. We use a balanced budget in each year to compute T_t^e and T_t^p. We use the assumption of constant $k^{T^e}(a, a')$ and $k^{T^p}(a, a')$, together with demographic data, to compute the distribution of taxes across individuals in each year. Given this, we compute the rates of return. This policy gives

Cohort 1990

$$i = 7,46\%; \pi = 7,95\%$$

Cohort 1974

$$i = 7,47\%; \pi = 7,87\%$$

Cohort 1950

$$i = 7,57\%; \pi = 7,31\%$$

Most surprisingly, at least to us, this policy manages to maintain the two implicit rates of return remarkably close to each other, even under such a rapidly changing demographic structure. Furthermore, the absolute level of the two rates of return moves very little from wher it was in the baseline case and, more important, remains close to what has been the Spain's historical real rate of return on capital, i.e. about 7%. Keeping per-capita expenditure constant, in real terms, seems therefore a reasonable first-order approximation to what, within the constraints of the current welfare system, we could label as the "optimal response" to the foreseeable Spanish demographic change.

This result becomes even more remarkable when one looks at the performances of the other, somewhat "natural", policy response, i.e. the one that keeps constant the level of individual taxation financing the two functions.

Scenario B Here we fix real per capita taxation T_a^e and T_a^p at the base case level, for all a. Then we proceed as in Scenario A, using the assumption of constant $k^E(a, a')$ and $k^P(a, a')$ to compute the yearly distribution of E_t and P_t across individuals of different ages. This policy gives.

Cohort 1990

$$i = 5,90\%; \pi = 4,77\%$$

Cohort 1974

$$i = 7,43\%; \pi = 5,03\%$$

Cohort 1950

$$i = 7,65\%; \pi = 6,98\%$$

The outcome here is dramatically different. Particularly for younger cohorts, the two rates of return move substantially away from each other and, for the 1990 cohort, quite below the real rate of return on capital. On the basis of this preliminary analysis one should conclude that a policy that keeps per-capita expenditure constant in real terms, and adjust taxation in order to roughly balance the year by year budget constitute a reasonable response to the forthcoming demographic change. The first best response, naturally, is to reform the whole system so as to incorporate and make automatic the pursuance of the efficient rate of return equality.

5. Conclusion

We extend the model of efficient intergenerational transfers via public education and pensions of Boldrin and Montes (2005) to evaluate the efficiency of the current Spanish welfare system and its ability to handle demographic change. The theoretical model says that a necessary condition for efficiency is that two rates of return implicit in the flows of educational services, social security contributions, educational tax payments, and pension receipts, should be equalized. The extension considered here takes into account how the optimal policy should react to demographic shocks, and an optimal policy response is derived.

Next we use our theory to measure if the Spanish system is close or far from the social optimum. To do this we use both microeconomic and aggregate data for Spain in 1990-1991, and 1998-1999, to compute the two implicit “borrowing” and “lending” rates. For the baseline case in which strong stationarity assumptions are imposed our point estimates of the borrowing and lending rates suggest that, at the end of the 1990s, the Spanish welfare system would not have been very far away from efficiency, had the existing demographic situation persisted over time. Nevertheless, demographic stationarity is not what Spain, or most other countries for that matter, faces. Once this is taken into account the results change dramatically.

We try to understand which policies, if any, could attenuate the inefficiency and the related intergenerational redistribution that demographic change is bringing along given current policies. To do this we have considered two sets of policy changes that, prima facie, appear “reasonable” or even “likely”. In the first case we assume that per capita expenditures (transfers) are kept constant at the 1998-99 level, while taxes adjust to balance the education and pension budgets every year. In the second we do the reverse, hold per capita taxes and contributions at the old level and let expenditures/transfers adjust to balance the budget.

Much to our surprise, the two policies perform quite differently under the most realistic demographic scenario one can envisage on the basis of currently available information. The policy that keeps per-capita expenditure constant does very well, i.e. keeps the two rates of return almos unchanged and close to each other. The policy that keeps constant per-capita taxation does poorly, signalling a dramatic increase in intergenerational redistribution and a movement away from the efficient allocation. In particular, pensions tend to yield a rate of return (on the previous education investment) *lower* than the rate of interest the working cohorts are expected to pay (via social security contributions) on the education services they received. In other words, should the Spanish Government keep taxing its citizen at the current rates for the purpose of financing pensions and education, and then spend in the two systems so as to balance the yearly budget, both pensions and educational expenditures would be too low, and pensions especially so. This is a surprising result, but only partially so in retrospect. The public sector data we use to extrapolate future policies come from a sequence of years in which the burden of taxation was particularly high in Spain, and both the public sector budget and the social security budget were heading toward substantial surpluses, which they have in fact be running for a number of consecutive years now.

Another relevant empirical finding is the following. Contrary to a widespread presumption, the movements away from efficiency and intergenerational fairness are monotone in the direction opposite to what is usually expected. In particular, they do not seem to favor the older relative to the younger generations. While the latter are predicted to receive a much smaller rate of return, through pension payments, on their educational investments, they are also predicted to have to pay a much lower rate of interest on the educational transfers they received during their youth. If one measures "redistributions" by taking the difference between i (what people pay) and π (what people receive) for each generation, it is the intermediate generation (the one born in 1974 in our case) that gets the worst deal. The oldest (1950) receives the best treatment and the youngest (1990) falls in between. In other words, *rebus sic stantibus*, the expected demographic evolution should not necessarily lead to a huge redistribution of resources away from the younger or not-yet-born generations and toward people that are now approaching retirement age. It is the generation now approaching its middle age that appears to be the looser in the Spanish intergenerational redistribution game. Most previous findings, based on the generational accounting methodology pioneered by Auerbach and Kotlikoff (see, for example, Auerbach, Kotlikoff, and Leibfritz (1999)), have instead shown that the interaction between demographic change and current fiscal policies (in particular, current welfare policies) is likely to engender a large intergenerational redistribution in favor of the older cohorts. While our findings cannot rule out this conclusion and, in fact, support it under certain policy scenarios, we believe our estimates have independent value and should shed some additional light on the intricacies of intergenerational public policy.

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Appendix: Data Sources and Treatment

A.1 Data sources

Our sources of data are the following.

We obtain the aggregate expenditure on public education from the *Estadística del Gasto Público en Educación* (EGPE 1995, in Ministerio de Educación y Ciencia (1995)) and the *Encuesta sobre Financiación y Gasto de la Enseñanza Privada* (EFGEP 1990-91, in INE (1992b)). The first data base contains public expenditure for each schooling level; the second reports the amount of public funding going to private schools (*centros concertados*). Aggregate tax revenues are obtained from the *Cuentas de las Administraciones Públicas* (IGAE (1991b)). From this we extract the share of total tax revenues allocated to financing public expenditure on education, excluding the fraction covered with public debt. We assume that the fraction of public expenditure covered by debt financing is equal to the average share of public expenditure financed by debt during 1990-91.

Aggregate flows of public pension payments are obtained from the *Cuentas de las Administraciones Públicas* (IGAE (1991b)) and *Actuación Económica y Financiera de las Administraciones Públicas* (IGAE (1991a)).

The conditional survival probabilities at each age are equal to those obtained by the latest mortality tables published by the National Statistical Institute (INE (1999) with reference to the year 1998.

The aggregate data do not allow the study of individual lifecycle behavior. To do this, we use a Spanish household budget survey (*Encuesta de Presupuestos Familiares*, or EPF) carried out by INE (1992a), in 1990-91. This survey contains data on individual income, expenditure, personal characteristics, and demographic composition for 21,155 households and 72,123 Spanish citizens. This survey is representative of the entire Spanish population and is calibrated on the Spanish Census data.

A.2 Treatment of the data

A.2.1 Lifetime distributions

We now detail how, using the data in the EPF, we calculated the lifetime distribution of the four flows associated to the two public systems.

The information in the EPF allows the estimation of the contributions and payments associated to the two public systems for each individual in the sample.

These contributions and payments depend upon the labor market condition of the individual. Thus, we have considered five states in which each individual can be. For each state we compute contributions and payments the individual receives or makes. These five states are the following:

($\mathcal{E}$) *Student.* The individual is enrolled in a school or university receiving public funds. The individual is then receiving a transfer (E_a^i) of an amount equal to the average cost of a pupil of his/her age attending a school of the kind he/she specifies, during the fiscal year 1990-91. The same individual contributes toward financing of public education through a portion of his/her direct and indirect taxes, (T_a^i).

($\mathcal{W}$) *Worker.* This class includes all employed individuals. Such individuals pay direct or indirect taxes to support public education, (T_a^i), and also pay social security contributions, (T_a^{pi}).

($\mathcal{R}$) *Retired.* We consider as retired only those individuals receiving a contributive pension (P_a^i). Retired individuals are also financing the public education system with a portion of their taxes (T_a^i).

($\mathcal{U}$) *Unemployed.* If an individual receives unemployment benefits, he/she is financing the public pension system through the social security contributions paid, (T_a^{pi}). Again, the unemployed are also financing the public education system with a portion of their taxes (T_a^i).

($\mathcal{I}$) *Inactive.* Here we include all the individuals that are not in any of the previous four states. If these individuals pay some income taxes, this is recorded in the EPF. Otherwise, we attribute to them a share of the indirect taxes based on their reported expenditure. The total gives (T_a^i).

These five states are mutually exclusive. For the very rare cases in which the same individual in the EPF reports to be in two or more of them, we create two or more "artificial" individuals and increase the sample size correspondingly . We define the universe of states to be $\mathcal{S} = \{\mathcal{E}, \mathcal{W}, \mathcal{P}, \mathcal{U}, \mathcal{I}\}$. The total population at each age $a = 1, \ldots, A$ is $\sum_{s \in \mathcal{S}} L_a(s)$, with $L_a(s)$ equal to the number of individuals of age a that are in state s. Denote the share of the population of age a in state s as $\mu_a(s) = L_a(s) / \sum_{s \in \mathcal{S}} L_a(s)$, with $\sum_{s \in \mathcal{S}} \mu_a(s) = 1$. For each a and $s \in \mathcal{S}$, $\mu_a(s)$ is the probability that an individual is in state s at age a.

A.2.2 Public education system

In Spain, public financing of education is allocated in part to public schools and in part to a special kind of private schools, *centros concertados*, by means of school vouchers to students. At the compulsory school level (up to age 14 in 1990, 16 in the current legislation) schooling is completely free. After that, students attending public institutions pay only a small fraction of the total cost, the rest being born by general tax revenues. Students attending private institutions bear the full cost.

Cost of public schooling

For each educational level (primary, secondary, higher, and other), we have computed the real per-pupil public expenditure on education for various types of schools (public and *concertados*) and for the public universities. The EPF reports if an individual is enrolled in school, the type of school (public or private), and the level he/she is attending. This information is enough to compute the total number of students in each level, type of school, and age group. The criterion we followed to compute the cost of schooling for each "kind" of student (age a, level j, type k of school) is the following. From the EGPE and the EFGEP we obtain the actual total amount of public expenditures for each kind (kj) of school. We divide these amounts by the total number of pupils attending each. This gives us the effective per-student cost for each kind kj of school, E^{jk}. From the EPF we compute how many students of age a are attending a school of kind kj. Using this, we estimate public school expenditure on the representative individual at each age a as

$$E_a = \mu_a(\mathcal{E}) \sum_{k \in TC} \sum_{j \in NE} \mu_a\left(\mathcal{E}^{jk}\right) E_a^{jk} = \mu_a(\mathcal{E}) \overline{E}_a$$

where $\mu_a(\mathcal{E})$ denotes the fraction of the population of age a attending school, NE is the universe of educational levels, and TC is the universe of types of schools. Finally, $\mu_a\left(\mathcal{E}^{jk}\right)$ is the portion of students of age a enrolled in the educational level j in a school of type k.

The age distribution of public education "borrowing" is

$$\delta_a = \frac{E_a}{\sum_{a=1}^{A} E_a L_a}.$$

Hence, δ_a is the share of (lifetime total) education-related transfers the representative individual receives at age a.

Financing of the public education system

On the financing side, we need to compute the amount of education-related taxes paid by the representative individual at age a. The taxes we consider are the following: personal income tax (*Impuesto sobre la Renta de las Personas Físicas*, or IRPF), Value Added Tax (VAT), special, and other local taxes.

The EPF provides detailed information about the income flow of each individual and the wealth and consumption baskets of each household. This allows a detailed reconstruction of the various taxes paid by an individual, which we then aggregate in a total burden of taxation (T_a^i) for individual i of age a. We calculate the average tax paid by a person of age a as

$$T_a = \sum_{s \in \mathcal{S}} \mu_a(s) \frac{\sum_{i \in s} T_a^i}{L_a(s)} = \sum_{s \in \mathcal{S}} \mu_a(s) \overline{T}_a^s$$

where $\overline{T}_a^s$ is the average tax paid by an individual in state s at age a.

Given the values T_a for $a = 1, \cdots, A$, the computation of the lifetime distribution of the total investment in public education is straightforward:

$$\alpha_a = \frac{T_a}{\sum_{a=1}^{A} T_a L_a}.$$

Hence, α_a represents the relative burden of taxation charged to the representative individual at age a, for $a = 1, \cdots, A$, Call this the age distribution of the total tax burden.

To impute the flow of real expenditures in education to the various years of one's life, we need to scale the coefficients α_a by the actual public expenditure on education. We retrieve this from IGAE (1991b); call it T_{90}^e. Then we compute $T_a^{e*} = \alpha_a \cdot T_{90}^e$ for $a = 1, \cdots, A$, the investment in public education for the representative agent.

A.2.3 Public pensions

Public contributory pensions are provided by the following programs. The General Social Security Regime (*Régimen General de la Seguridad Social*, or RGSS) is the main one and covers most private sector employees plus a (small but growing) number of public employees. The five plans included in the Special Social Security Regimes (*Regímenes Especiales de la Seguridad Social*, or RESS) are for the self-employed (*Régimen Especial de Trabajadores Autónomos*, or RETA), the agricultural workers and small farmers (*Régimen Especial Agrario*, or REA), the domestic employees (*Régimen Especial de Empleados de Hogar*, or REEH), the sailors (*Régimen Especial de Trabajadores de Mar*, or RETM) and the coal miners (*Régimen Especial de la Minería del Carbón*, or REMC). Finally, there exists a seventh, special pension system for the public employees (*Régimen de Clases Pasivas*, or RCP).

Financing the public contributive pension system

All seven pension regimes are of the pay-as-you-go-type and, presumably, are self-financing[8]. To estimate the lifetime distribution of social security payments, we identified all individuals in the EPF paying social security contributions and split them among the seven plans. For each individual we have enough information, either from the EPF or from current legislation (for example, for public employees) to compute the fictitious income (*bases de cotización* and *haberes reguladores*) upon which pension contributions are being charged. To each of the fictitious incomes we apply the social security contribution rate, as specified by the 1990-91 legislation, for the pension regime in which the individual was enrolled. Aggregating these amounts over all the individuals of age a, we obtain, for each $a = 1, \ldots, A$, the amount of social security contributions paid by individuals in state $\mathcal{W}$ ($T_a^{\mathcal{W}}$) and state $\mathcal{U}$ ($T_a^{\mathcal{U}}$). The social security contribution paid by the representative agent at age a is then

$$T_a^p = \mu_a(\mathcal{W}) \cdot T_a^{\mathcal{W}} + \mu_a(\mathcal{U}) \cdot T_a^{\mathcal{U}}.$$

Also in this case, we compute weights by setting

$$\beta_a = \frac{T_a^p}{\sum_{a=1}^{A} T_s^p L_a}$$

Finally, from IGAE (1991a, b) we obtain the total amount of social security contributions paid to the seven plans during the year 1990, T_{90}^p. In our simulation, we use

$$T_a^{p*} = \beta_a \cdot T_{90}^p.$$

Benefits of the public pension system

The Spanish social security system provides five types of contributive pensions: old-age, disability, widowers, orphans, and other relatives. We have not considered payments of noncontributive pensions as part of our scheme, as they are not financed by means of social security contributions.

[8] The RGSS shows a surplus. The five special regimes show small deficits.

In the EPF, we are told if an individual is a pension recipient, what kind of pension he or she receives, and in what amount. The average contributive pension received at each age a is therefore easily computed as

$$P_a = \mu_a(\mathcal{P}) \cdot \sum_{k \in TP} \mu_a(\mathcal{P}^k) \cdot \frac{\sum_{i \in k} P_a^i}{L_a(\mathcal{P}^k)} = \mu_a(\mathcal{P}) \overline{P}_a$$

where $\mu_a(\mathcal{P})$ is the fraction of the population of age a receiving a contributive pension, TP is the universe of kinds of contributive public pensions, $\mu_a(\mathcal{P}^k)$ is the portion of pensioners at age a receiving a pension of type k, P_a^i is the actual pension received by individual i of age a, and $L_a(\mathcal{P}^k)$ is the number of individuals of age a receiving a pension of type k.

As in the previous cases, the lifetime weights are computed as

$$\gamma_a = \frac{P_a}{\sum_{a=1}^{A} P_a L_a}.$$

Finally, from IGAE (1991a, b) we obtain the total contributive pension payments effectively made, by the seven regimes, during the year 1990, P_{90}. The amounts used in our calculations are, therefore, $P_a^* = \gamma_a \cdot P_{90}$.