REGIONAL DIFFERENCES, EDUCATION POLICY, AND THE SUSTAINABILITY OF THE PENSION SYSTEM

Alessandro Balestrino[*]

Abstract. We use an overlapping generation model with non-altruistic parents, endogenous fertility and two regions to study the effects of alternative designs for education policy on the sustainability of pay-as-you-go social security. The pension system reduces fertility, thereby eroding its own tax base: we ask whether education policy helps to counteract this tendency. We consider centralised, co-ordinated and decentralised education policies, and find that, in general, decentralisation enhances the viability of the pension system, as it allocates the burden of taxation in such a way that fertility is encouraged. *Journal of Economic Literature* Classification Numbers: H52, H55

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[*] Dipartimento di Scienze Economiche, Università di Pisa

1. Introduction

This paper concerns (and tries to establish a link between) two questions which are today at the centre of the political and institutional debate in many countries. The first issue concerns education policy and more precisely the extent to which it should be decentralised rather than managed at the central level. The second issue concerns the sustainability of the pay-as-you-go (for short, PAYG) pension system, which is being jeopardised by the ageing of the population in most western countries.

The debate on centralisation vs. decentralisation in education policy involves not only scholarly investigations, but affects the policy practices of many governments as well. The chosen strategy varies from country to country: for instance, we have a strong decentralisation in the US, and a high centralisation in France and Italy (see e.g. Costrell 1997 and the references therein). Moreover, the situation is not stationary in these countries: on the one hand, there has been a movement for establishing national standards in the US; on the other hand, several steps towards a greater decentralisation have been taken in European states such as Great Britain, and those advocating this policy are increasing in number elsewhere (e.g. in Italy).

The sustainability of social security is also a hotly debated issue. The pay-as-you-go pension systems operating

today in most western countries have been recently subjected to a strong pressure, as the fall in fertility and the consequent ageing of the population imply that the number of tax payers is constantly falling relative to that of the pensioners. Some countries, like Italy and Sweden, have modified their systems in order to mimic a fully funded scheme (benefits are related to contributions); others, like Chile, and to a certain extent, Great Britain, have moved towards a privatisation of social security; others, like Germany, Spain or Belgium have introduced minor changes without altering the basic structure of the system. Especially for the countries of this latter group, the governments will have to face, sooner or later, a hard choice between rising taxes and reducing benefits[1] (in the era of the Maastricht treaty, the expansion of public debt is no longer an option).

In this paper, we will not be interested in the educational system or in the pay-as-you-go social security scheme *per se*; rather, we will focus on the relation between the two, and more precisely on the impact of education policy on the pension system. Previous contributions on this subject include Konrad (1995), who argues that in a "gerontocracy" (i.e. an economy where the political power is in the hands of the old), there is an incentive to provide education publicly, because this leads to higher wages via the accumulation of human capital. In turn, higher wages imply an increase in revenue, to be used for the funding of social security schemes.

This line of reasoning (employed in other contributions such as that by Nystedt 1998) exploits one specific link between education policy and social security, that is the one provided by the growth of wage rates. *Here, we take a different approach, focusing on the link given by the fertility level*. Notice that this line of enquiry presupposes that we assume, unlike Konrad and Nystedt, endogenous fertility.[2] Public actions affecting the families' educational choices have a strong effect on fertility choices as well; this will have consequences, in due course, on the viability of PAYG social security schemes. It has been argued (e.g. by Cigno 1993), that PAYG pension systems are intrinsically unstable, because social security reduces fertility by making children less valuable as a means for supporting the old and therefore erodes its own tax base (when it is of the PAYG variety). We will investigate this question in the paper from what we hope is a new perspective, namely by asking whether the form taken by education policy is of some relevance for the sustainability of the pension system. No doubt, a stylised model such as ours can only offer tentative answers. Nevertheless, knowing that, at least in principle, a certain type of education policy can be expected to be better than others in this respect is of some rilevance, because, although the sustainability of social security can be enhanced in a number of ways, none of these seems to have a strong effect in isolation. For instance, Börsch-Supan (1998) argues that common measures like increasing retirement age or

incentivating labour force participation and immigration[3] will not be able to fix the sustainability problem unless they can work together. Therefore, adding one more item to the list of the possible measures can only be helpful.

Besides adding a new perspective from which to view the relationship between education and pensions, we try to make with this paper one more contribution by introducing regional differences. These may be relevant in a federal State as well as in international federation such as the European Union: with a unified labour market, the question of whether there should be a single European standard for education will sooner or later arise in all its strength. Also, the question whether there should be a unified European pension system is currently being investigated (see Breyer and Kolmar 1998 and the references therein). The question is: differences in what? It is hard to say which among the many ways in which regions may differ is the most relevant for our purposes. We have selected one that, although cannot be claimed to be the only significant trait, certainly has some bearing on our question: namely, differences in skill. In our model, there are two regions, *H* and *L*, and it is assumed that individuals are more able in *H* than in *L*. One straightforward way of interpreting this is to see it equivalent to the assumption that the innate human capital of those living in *H* is on average higher than that of those living in *L*, perhaps due to different institutional settings.

The paper is structured as follows. In section 2, we set

up the basic model of household choice. In section 3, we study the effects of three alternative designs for education policy on the fertility level and on the pension system. Section 4 sums up.

2. HOUSEHOLD CHOICE

Consider an overlapping generations economy with two regions; for simplicity, we take it that households within each region are identical, while the interregional difference is given by an ability parameter. We also assume that households are made of a single parent and that this parent is selfish, i.e. it derives utility from its consumption only. Each household lives for three periods of equal length (youth, middle-age and old-age) and has an income only when middle-aged. Children cannot borrow in the market (realistically, we assume that it is difficult to obtain credit for future labour income), so that survival in the first period depends solely on transfers from the parent, whereas one can provide for its old age using, in principle, a mix of savings, public pensions and transfers from one's adult children. Children are born to middle-aged parents, who control their fertility level. The policy variables (which are parameters from the household's point of view) include freely provided education[4] for the young and a pension benefit for the old, financed out of taxes levied on the adults.

The family transfers system

If preferences are convex, households will be better-off if they can smooth their consumption stream across periods. One way of doing this is to rely on the family transfers; to illustrate how they work, we draw heavily on the model by Cigno (1993). Suppose that there are, within each extended family, dynastic rules (what Cigno 1993 calls a "constitution") establishing *i*) that middle-aged households have to make a money transfer to their own old parents, and provide for the survival of their children, and *ii*) the criterion according to which the payments have to be computed.

Let us focus on point *i*) first. We can think of the transfers to the young as loans, and of the transfers to the old as loan repayments. This way, by having children and supporting them, a parent becomes entitled to receive a transfer in its old age. However, since households are selfish and the intrafamily deals cannot be enforced by law, how can we make sure that the transfer system works? One way of doing this is to look for conditions that make the rules *self-enforcing*: actually, we need two such conditions. First, we have to make sure that the transfers system is viable in the presence of outside opportunities: since a middle-aged household can provide for its old age by lending to the market, the expected rate of return associated with the intrafamily transfers must be high enough to make them profitable. In particular, the return from the first child in terms of the internal transfers must be higher than the

market return to savings (otherwise households will have no children). If that is the case, and if the return to a child decreases with the number of children, the fertility level will be driven up to the point in which the marginal benefit from having children equals its opportunity cost, that is the market rate of return. Second, we need a clause protecting the family network against the risk that someone defaults, i.e. has children and supports them in order to get a transfer once old, but does not re-pay its own parent. To avoid this, we suppose that the rules state that if a parent does not pay its debt back, its children will be permitted to do the same. Since the threat is credible (it is in the children's interest to carry it out), the best strategy for a middle-aged household will to re-pay his debt, *if* its parent has also obeyed the rules. This way, the set of all the strategies is a sub-game perfect Nash equilibrium, as anybody's best response is to follow the rules, at the same time threatening to punish those who don't.[5]

Consider now point *ii*) above, that is the criterion for computing the family transfers. We assume that the family constitution prescribes a sharing rule, which is taken as given by all the generations coming after the one who actually "wrote" the constitution. That is, the constitution determines the fraction a^* of the disposable income of the adults which has to be tranferred to the old as a loan repayment. What can we say about a^*? To begin with, it will be between 0 and 1, both excluded. Indeed, if it were zero, the parents, being selfish,

would not lend to their children and hence the family network would not be operating; if it were one, then the children could not survive when middle-aged. To be more precise, we can further suppose that the sharing rule is fixed *as if* it were the outcome of an actual bargaining process between middle-aged parents and their children. What would have happened if such bargain took place? Note that the only way for a child to survive is to rely on his or her parents' income; the children have no bargaining power and all the surplus will accrue to the parents. So, the forefathers who "wrote" the constitution (being selfish, utility-maximising adults) will have fixed a^* so as to reap the maximum possible return from the transfers system, leaving to their adult children no more than the subsistence consumption level. We derive formally a^* below.

The formal model

The household optimisation problem is:

$$\begin{aligned} \max_{s,n} \quad & u_t^i = u\left(b_t^i, c_t^i, c_{t+1}^i\right) \\ \text{s.t.} \quad & c_t^i = \left(1-a^{*i}\right)\left(w\left(\bar{e}_{t-1}^i, \beta^i\right) - T_t^i - G_t^i\right) - \\ & - n_t^i b_t^i - \gamma\left(n_t^i\right) - s_t^i, \\ & c_{t+1}^i = n_t^i a^{*i}\left(w\left(\bar{e}_t^i, \beta^i\right) - T_t^i - G_t^i\right) + \\ & + \left(1+r_t^i\right)s_t^i + P_{t+1}^i, \end{aligned} \tag{1}$$

where $i=H,L$ indexes the region (ability is lower in L than in H); t indexes the period; b is a consumption transfer received when young (due to the parents being selfish, this will be

presumably equal to the subsistence level); c is consumption; a^* is the share of disposable income going to the parents; w is the wage rate, which depends on the publicly provided education $\bar{e}$ (acquired one period before) and on the ability parameter β, and it is earned by supplying inelastically one unit of labour; T and G are the lump-sum taxes needed to finance the pay-as-you-go pension system and the public provision of education, respectively; P is the pension benefit; n is the number of children;[6] $\gamma(n)$ is a strictly convex function representing the out-of-pocket costs of child-rearing (other than b); s is savings; and r is the market rate of interest. At this stage, we do not impose any structure on the policy tools and the other parameters: we have allowed for the possibility that each of them is region- as well as period-specific. The first order conditions are:[7]

$$(a) \quad -\frac{\partial u_t^i}{\partial c_t^i}\left(b_t^i + \gamma'\left(n_t^i\right)\right) + \\ + \frac{\partial u_t^i}{\partial c_{t+1}^i}\left(a^{*i}\left(w\left(\bar{e}_t^i, \beta^i\right) - T_t^i - G_t^i\right)\right) = 0 \qquad (2)$$

$$(b) \quad -\frac{\partial u_t^i}{\partial c_t^i} + \frac{\partial u_t^i}{\partial c_{t+1}^i}\left(1 + r_t^i\right) = 0$$

Let the return to a child be:

$$m\left(n_t^i; a^{*i}, \beta^i, b_t^i, \bar{e}_t^i, T_t^i, G_t^i\right) = \\ = \frac{a^{*i}\left(w\left(\bar{e}_t^i, \beta^i\right) - T_t^i - G_t^i\right)}{b_t^i + \gamma'\left(n_t^i\right)} \quad . \qquad (3)$$

Note that since γ is convex by assumption, *m* will be decreasing in *n*:

$$\frac{\partial m_t^i}{\partial \hat{n}_t^i} = \frac{\partial m_t^i}{\partial \gamma}\gamma''\left(\hat{n}_t^i\right) < 0 . \tag{4}$$

It is now straightforward to rearrange the first order conditions to yield:

$$\begin{aligned} &(a) \quad m_t^i = \left(1 + r_t^i\right) \\ &(b) \quad \left(1 + r_t^i\right) = MRS_{t,t+1}^i \end{aligned} . \tag{5}$$

where $MRS_{t,t+1}$ is the marginal rate of substitution between consumption in period 2 and consumption in period 3. Eq (5a) says that at the optimum the marginal return from having children must equal the opportunity cost (the market rate of return); similarly, eq. (5b) says that the return from savings must equal its cost in terms of deferred consumption. We assume that $m > (1+r)$ at $n = 0$; this, in view of eq. (4), ensures that eq. (5a) will be satisfied for some $n > 0$.

The solution to problem (1) will be denoted:

$$\hat{n}_t^i = n\left(a^{*i}, \beta^i, b_t^i, \bar{e}_t^i, T_t^i, G_t^i\right), \tag{6}$$

$$\hat{s}_t^i = s\left(a^{*i}, \beta^i, b_t^i, \bar{e}_t^i, T_t^i, G_t^i\right). \tag{7}$$

For future reference, we now derive the comparative statics properties of the equilibrium by implicitly differentiating eq. (5a).[8] To sign the derivatives, assume that:

$$\frac{\partial w_t^i}{\partial \bar{e}_t^i} > 0 \quad \text{and} \quad \frac{\partial w_t^i}{\partial \beta^i} > 0. \tag{8}$$

It is now straightforward to check that, from eqs. (3) and (8):

$$\begin{aligned} &\frac{\partial m_i^t}{\partial a^{*i}} > 0, \frac{\partial m_i^t}{\partial \beta^i} > 0, \frac{\partial m_i^t}{\partial b_t^i} < 0, \\ &\frac{\partial m_i^t}{\partial \bar{e}_t^i} > 0, \frac{\partial m_i^t}{\partial T_t^i} = \frac{\partial m_i^t}{\partial G_t^i} < 0, \end{aligned} \tag{9}$$

Then, using eqs. (4) and (9), we get:

$$\frac{\partial \hat{n}_t^i}{\partial a^{*i}} = -\frac{\partial m_t^i / \partial a^{*i}}{\partial m_t^i / \partial \hat{n}_t^i} > 0, \tag{10}$$

$$\frac{\partial \hat{n}_t^i}{\partial \beta^i} = -\frac{\partial m_t^i / \partial \beta^i}{\partial m_t^i / \partial \hat{n}_t^i} > 0, \tag{11}$$

$$\frac{\partial \hat{n}_t^i}{\partial \bar{e}_t^i} = -\frac{\partial m_t^i / \partial \bar{e}_t^i}{\partial m_t^i / \partial \hat{n}_t^i} > 0, \tag{12}$$

$$\frac{\partial \hat{n}_t^i}{\partial Z_t^i} = -\frac{\partial m_t^i / \partial Z_t^i}{\partial m_t^i / \partial \hat{n}_t^i} < 0, \quad Z = T, G. \tag{13}$$

Eqs. (10)-(13) have a simple interpretation: fertility is positively correlated to the rate of return to a child, *m*, and therefore each parameter enhances or reduces fertility depending on whether *m* is increasing or decreasing in that parameter.

To complete our characterisation, we need a formal derivation of a^*. Let us conventionally set t=1 for the period in which the constitution was written; use d to denote the subsistence consumption level for adults; assume that b and d were the same for both regions; suppose, plausibly, that there was no public policy and no capital market at the time, so that

$\hat{s}^i = \bar{e}^i = G^i = T^i = 0$. Then, from the discussion above, we know that a^* will be the implicit solution to:

$$\left(1 - a^{*i}\right) w\left(0, \beta^i\right) - \hat{n}_1^i(\cdot) b_1 - \gamma\left(\hat{n}_1^i(\cdot)\right) - d_1 = 0 \qquad (14)$$

where the optimal n as determined by eq. (6) is adjusted as a^* varies, and $w(0,\beta)>0$. To check the existence and uniqueness of a^*, rewrite eq. (14) slightly as:

$$w\left(\beta^i\right) - d_1 = a^{*i}\ w\left(\beta^i\right) + \hat{n}_1^i b_1 + \gamma\left(\hat{n}_1^i\right) \equiv K(a^*). \qquad (15)$$

It is immediate to see that:

$$\lim_{a^* \to 0} K(a^*) = 0, \quad \lim_{a^* \to 0} K(a^*) > \left(w\left(\beta^i\right) - d_1\right)$$
$$\text{and} \quad \frac{\partial K}{\partial a^*} > 0 \qquad (16)$$

where the sign of the derivative follows from eq. (10). Therefore, K will intersect in the (a^*,K)-space the straight line representing $(w - d) > 0$ only once; i.e. a^* exists and is unique.

Note that owing to the differences in ability, a^* will in general differ across regions. Implicit differentiation of eq. (14) yields:

$$\frac{\partial a^{*i}}{\partial \beta^i} = -\frac{\left(1 - a^{*i}\right)\dfrac{\partial w^i}{\partial \beta^i}}{-\dfrac{\partial K}{\partial a^{*i}}} > 0 \qquad (17)$$

This is intuitively reasonable: the higher is β, the higher is income, and hence the lower is the fraction of that income which has to be left to the children to guarantee the subsistence level d. Then, we know that $a^{*H} > a^{*L}$.

This array of comparative statics results tells us that in general the fertility level will differ across regions at any given period. Unfortunately, at this level of generality, it is impossible to say whether $n^H > n^L$ or viceversa. In order to gain some insight into the matter, we make a few simplifying assumptions. If the economy is stationary, and we have $b^H = b^L$ (the subsistence consumption for the young is the same for both regions), $r^H = r^L$ (capitals are perfectly mobile across regions) and $\bar{e}^i = G^i = P^i = T^i = 0$ (there is no public policy), then eqs. (10), (11) and (17) tell us that $\hat{n}^H > \hat{n}^L$. This is quite plausible: higher levels of a^* and β imply, other things being equal, that the return to a child is higher, so that there is a stronger incentive to have children.

3. GOVERNMENT POLICY

Reasons of tractability suggest that, in order to study government policy, we make some simplifying assumptions. We take the configuration we have just used for establishing that $\hat{n}^H > \hat{n}^L$ (steady-state, $b^H = b^L$ and $r^H = r^L$, and no public policy) as the starting point for our analysis in this section. We will suppose that, in a given period *t*, the government steps in by launching its social security and education programs, and we will investigate how alternative forms of education policy affect the fertility level and thus the sustainability of the pension system. Moreover, to perform the analysis, we have to

make an assumption concerning the extent to which the government foresees the fertility changes induced by its own policies. A possible hypothesis is that the government underestimates these changes, that is it acts on the presumption that rate of population growth is basically unaffected by the households' reactions to its own choices. Indeed, one may argue that pay-as-you-go pension systems were implemented in the real world without realising that they would have reduced fertility, thereby eroding their own tax base. Later, when the damage was already done, this problem has been understood and remedies have been applied; but, the original impact on fertility couldn't be undone. For simplicity, we make the extreme assumption the government does not take at all into account the families' fertility decisions when introducing its policies, i.e. the government believes that fertility is exogenous. This simplifies matters considerably - especially for the derivation of eq. (22) below -, but it is *not* essential to our arguments. As we shall see, the driving force behind the results is the disparity in population size between the regions, a disparity that comes from the natural demographic evolution which took place before the government intervention.

Social security, endogenous fertility and education policy

In our setup, the pension system may be run on a national basis, with a unique revenue constraint, or can be decentralised at the regional level, with separated revenue

constraints. The former case would be more likely if we apply the model to a federal State, whereas the latter case would presumably prevail in an international federation. In any event, we take P as fixed, and assume that the government or the region would like to adjust T so as to ensure that the social security budget is balanced in each period (i.e., T should be such that the number of taxpayers times T equals the number of pensioners times P). This would represent what is called a fixed-benefit pension system, operating e.g. in Italy until 1995 for all pensioners and still in force for all those who have retired from work before that year.

The key question here is the relation between fertility and revenue. The problem is that under endogenous fertility, the number of tax-payers is not fixed, and, in particular, is influenced by the level of the contributions to the pension system and other forms of taxation. In our model, where the family transfer from the adults to the old is determined as a share of the disposable income of the former, all the taxes levied on the adults will reduce the amount paid to the old; thus, children will be less profitable and the households will lower their fertility - see eq. (13). So, if the government intervenes in a given period t, providing social security and imposing the necessary taxes without realising that fertility is endogenous, it will inadvertedly bring about a change in the number of taxpayes at t+1. In particular, T reduces fertility, so that the pension system will immediately jeopardise its own

viability: with a fixed P, T has to be increased to balance the budget at t+1 (thereby triggering a further reduction of fertility), or else the government must borrow on the capital market, and both options may be, for different reasons, unpalatable (we have discussed this in the introduction with reference to real world system).

We can, however, check whether education policy, also introduced at t, may counteract this tendency: we know from comparative statics that any increase in $\bar{e}$ will increase fertility by raising m, although G will reduce fertility. It would be interesting therefore to study how to design education policy in such a way to maximise its positive effects on the fertility level. In particular, in the presence of heterogeneous regions, the question arises of whether public provision of education should be based on uniform standards or on region-specific interventions. The first option could be advocated on grounds of horizontal equity arguments, such as equality of access to publicly provided services and equal treatment of citizens across regions, and it would result in what may be called a *centralised decision*. The second option gives much more weight to the preferences of the local communities: actually, the task of policy design can be given entirely and exclusively to them (*decentralised decisions*) or, instead, we can assign to the central government the duty of providing a minimum standard and leave to the regions the freedom to supplement this standard if they wish (*co-ordinated decisions*). Clearly,

also the way in which education expenditures are financed will change as the design changes. We have a uniform tax under centralisation, regional taxes under decentralisation, and a mix of the two under co-ordination (in this case, the standard would be financed by the central power, while the regional integration would be financed locally). The central government or the region, as the case may be, will want to choose the taxes in such a way the budget is balanced.[9] Therefore, the levels of $\bar{e}$ and G may vary depending on whether education policy is centralised, decentralised or co-ordinated. We would like to know which of the three designs for education policy is more useful in terms of the sustainability of the pension system, i.e. which of them allows to provide the largest possible education level with the lowest possible tax.[10]

The design of education policy

Education policies are fully characterised by a pair $(\bar{e}^i, G^i)$, where:

- in a centralised policy:
  $\bar{e}^i = \bar{e}$ and $G^i = E, \quad i = H, L$
- in a decentralised policy: $\bar{e}^i$ and G^i are fixed within each region;
- in a co-ordinated policy:
  $\bar{e}^i = \bar{e} + (\bar{e}^i - \bar{e})$ and $G^i = E + F^i \quad i = H, L$

When the policy is co-ordinated, education levels will be the same as with decentralisation, but the rations are not entirely provided at the regional level, and also the funding is partly *via* the uniform tax *E* and partly *via* the local tax *F*. As was the case for the pension system, the revenue constraints are set on the basis of the (wrong) assumption that the constant rate of population growth observed before the policy intervention will not change at *t*:

- in the centralised setting we have a nation-wide constraint:

$$\left(\sum_i \left(\hat{n}^i\right)^t\right) E = \left(\sum_i \left(\hat{n}^i\right)^{t+1}\right) \bar{e} \qquad (18)$$

- in the decentralised setting, each region has a separated constraint:

$$(\hat{n}^i)^t G^i = (\hat{n}^i)^{t+1} \bar{e}^i \text{, } i=H,L \qquad (19)$$

- in a co-ordinated policy, *E* satisfies the same budget constraint as in eq. (18), while the supplementing region(s) will have to set F^i in such a way that:

$$(\hat{n}^i)^t F^i = (\hat{n}^i)^{t+1} \left(\bar{e}^i - \bar{e}\right). \qquad (20)$$

To facilitate the comparison between the various policy designs, it is useful to have explicit expressions for the taxes. To this end, define:

$$N(t) = \frac{\sum_i (\hat{n}^i)^{t+1}}{\sum_i (\hat{n}^i)^t}. \quad (21)$$

Then, we write:

$$E = N(t)\bar{e},\ G^i = \hat{n}^i \bar{e}^i, \text{ and } F^i = \hat{n}^i\left(\bar{e}^i - \bar{e}\right) \quad (22)$$

Now, we can regard the list of numbers generated by varying t in eq. (21) as a sequence, written $\langle N(t)\rangle$. In the appendix we prove the following:

***Claim* 1**:

$$\begin{aligned} &(a) N(1) = \frac{\hat{n}^H + \hat{n}^L}{2}; \\ &(b) N(t+1) > N(t); \\ &(c) \lim_{t\to\infty}\langle N(t)\rangle = \hat{n}^L. \end{aligned} \quad (23)$$

Or, in words:

***Claim* 1bis**. *$N(t)$ equals the average population growth rate in the first period, and then gets monotonically closer to $\hat{n}^H$ as time passes.*

As a consequence, the level of the uniform tax E varies depending on how large t is. For concreteness, we will perform our analysis for the case in which the following holds:

***Condition* 1**. *t is "large", i.e. $N(t) \approx \hat{n}^H$.*

We can have now various scenarios. A possibility is that in the decentralised policy, both region impose a lower education standard than the central government (or the same standard) and, consequently, both will choose not to supplement the central standard in the co-ordinated policy. Or it may happen that one or both regions want to impose a higher standard. In what follows, we will discuss the six possible cases, three for each region, and then provide a unifying analysis.

The effects of alternative education policies

Case 1: $\bar{e}^L > \bar{e}$

Co-ordination and decentralisation have the same education standard, but the tax is lower under decentralisation: using eq. (22), we see that:

$$E + F^L = (\hat{n}^L \bar{e}^L + (\hat{n}^H - \hat{n}^L)\bar{e}) > \hat{n}^L \bar{e}^L = G^L \qquad (24)$$

in view of $\hat{n}^L < \hat{n}^H$. In practice, decentralisation prevents region *H* from shifting part of its larger tax burden on *L*: thus, from *L*'s point of view, it is preferred to co-ordination, as it keeps m^L higher. Next, we see that decentralisation guarantees a larger ration than centralisation, but requires a tax $G^L = \hat{n}^L \bar{e}^L$ that can be higher or lower than $E \approx \hat{n}^H \bar{e}$, as $\hat{n}^L < \hat{n}^H$, but $\bar{e}^L > \bar{e}$. Actually, we have that:

$$E \geq G^L \text{ if } (\bar{e}^L / \bar{e}) \leq (\hat{n}^H / \hat{n}^L), \qquad (25)$$

that is if *L*'education standard is not "too high" relative to the national standard; in that case, decentralisation is preferable. This is reasonable, as it suggests that a moderate increase of education above the national standard can enhance the benefits of having children at the cost of a little increase in the tax burden, in such a way that the net effect on m^L is positive. If eq. (25) holds, decentralisation is the best option for *L* in terms of sustainability of the pension system.

Case 2: $\bar{e}^L = \bar{e}$

Decentralisation and co-ordination are equivalent for region *L*, because the education standard is the same and so is the tax, as can be checked using eq. (22); they both dominate centralisation, as offer the same standard with a lower tax (from eq. (22) and Condition 1, one sees that $E \approx \hat{n}^H \bar{e} > \hat{n}^L \bar{e}^L = G$, in view of $\bar{e}^L = \bar{e}$ and $\hat{n}^L < \hat{n}^H$). This result arises, as before, because both decentralisation and co-ordination prevent *H* from shifting the burden of financing its own larger education expenditure to *L*.

Case 3: $\bar{e}^L < \bar{e}$

Co-ordination implies the same ration and the same tax than centralisation, so the two are equivalent. Instead, decentralisation guarantees a lower tax (again from eq. (22) and Condition 1: $G^L = \hat{n}^L \hat{e}^L < \hat{n}^H \bar{e} = E$ as $\hat{n}^L < \hat{n}^H$ and $\bar{e}^L < \bar{e}$), but at the cost of a lower education standard. However, using

the definition of m in eq. (3), we see that decentralisation will be better than the other two options if

$$\left|w\left(\bar{e}^{L},\beta^{L}\right)-w\left(\bar{e},\beta^{L}\right)\right|<\left|G^{L}-E\right|. \qquad (26)$$

That is, the benefit of having a lower standard in terms of reduced tax liability must be high enough to more than compensate the decrease in the wage rate, so that the net effect is to raise the return to children. Thus, if wages in region L are not too sensitive to changes in the education levels, decentralisation is the best option.

Case 4: $\bar{e}^{H}>\bar{e}$

Decentralisation and co-ordination are now equivalent for region H as they involve the same education standard and the same tax (indeed, we have from eq. (22) and Condition 1 that $E+F^{H}=\hat{n}^{H}\bar{e}+\hat{n}^{H}(\bar{e}^{H}-\bar{e})=\hat{n}^{H}\bar{e}^{H}=G^{H}$); they both involve a higher standard but also a higher tax than centralisation and will dominate it if

$$\left[w(\bar{e}^{H},\beta^{H})-w(\bar{e},\beta^{H})\right]>\left(G^{H}-E\right), \qquad (27)$$

The intuition is the opposite of the one used for eq. (26): the increase in the wage rate must be high enough to more than offset the increase in the tax liability in order to raise m^{H}. That is, if wages are highly responsive to changes in education levels, then decentralisation is preferable to both its alternatives from H's pont of view.

Case 5: $\bar{e}^H = \bar{e}$

From eq. (22) and Condition 1, it is immediate to see that if $\bar{e}^H = \bar{e}$, the three policy designs are equivalent in terms of their impact on fertility as far as region *H* is concerned. Indeed, the ration is the same in all three policy packages, and also the tax turns out to be the same. Thus, m^H does not change if we shift from a policy design to another. This happens because those living in *L* are too few relative to those living in *H* to make a difference: in practice, the expenditure on education is financed entirely within *H* with all three policy designs.

Case 6: $\bar{e}^H < \bar{e}$

This case is perfectly analogous to case 3 above, although it refers to *H* rather than *L*. The condition which corresponds to eq. (26) is:

$$\left| w\left(\bar{e}^H, \beta^H\right) - w\left(\bar{e}, \beta^H\right) \right| < \left| G^H - E \right|. \qquad (28)$$

which carries the same interpretation. Of course, this is rather in conflict with the requirement embodied in eq. (27), so that we expect that *either* eq. (27) *or* eq. (28) holds. Indeed, since region *H* is the one where ability is higher, it is plausible that wages are strongly responsive to increases in education standards, so that eq. (27) is satisfied.

The desirability of a decentralised education policy

For the economy as a whole, the ranking of the three policy designs will depend on how the six cases are combined. First, we single out the case in which both regions have the same standard as the central government. On the basis of the usual arguments for decentralisation, stressing the necessity to tailor public expenditure to the different needs of the different local communities, this would look like a case in which decentralisation and centralisation are equivalent. It turns out that this is *not* true as far as the sustainability of the pension system is concerned. Note first that co-ordination is not a real option, because neither region supplements. Furthermore, we saw that a centralised policy does not spread the tax burden equitably across regions, inducing those living in *L* to have less children and thus making the PAYG pension system more vulnerable (case 2). Since for region *H* decentralisation and centralisation are instead equivalent (case 5), we conclude that:

***Proposition* 1**. *Given eq. (22) and Condition 1, decentralised education policy is the best alternative in terms of the viability of the pension system if* $\bar{e}^L = \bar{e}^H = \bar{e}$.

The key to our result is the way in which a decentralised education policy allocates the tax burden between regions that differ in population size. This is perhaps best understood by contrast: if education standards are *not* funded locally, the more populated region, i.e. *H*, shifts part of its comparatively large

tax burden to the less populated one, i.e. *L*. Thus, *L*'s citizens suffer from a rising fiscal pressure (which lowers fertility) not necessarily compensated by a higher education standard, without really alleviating the pressure on *H*'s citizens, due the disparity in population size. Hence, decentralisation can be implemented at virtually no cost for *H*, and with great benefit for *L*. Depending on whether the pension system is national or regional, the benefits of a decentralised education policy can be spread over the national community or retained within *L*; therefore, region *H* might not gain from decentralisation, but, importantly, it will not suffer either.

We can now cover the other possible combinations of the six cases above as follows. Note first that cases 1 and 6 are arguably rather implausible: in the present model, education standards are exogenously given, but one can safely suppose that they will tend to be higher in region *H*, because the greater ability of its citizens makes education more valuable. So, we focus on cases 2-5. For them, we have that:

***Proposition* 2**. *Given eq.* (22) *and Condition* 1*, the most useful education policy in terms of the sustainability of the pension system for all the possible combinations of cases* 2-5 *is decentralisation, provided that eqs.* (26) *and* (27) *hold*.

In other words, suppose that wages are, as it is to be expected, more responsive to variations in education standards in the high-ability region than in the low-ability one - in the

sense made precise by eqs. (26) and (27); then, even if region *L*'s standard is lower and region's *H* standard is higher then the national one, decentralisation is still the best option. Provided that conditions (26) and (27) are satisfied, the intuition given for Proposition 1 applies equally well here.

Two concluding remarks are in order. First, we observe that co-ordination turns out to be a rather poor option, as it is either ruled out by decentralisation or is equivalent to one of the other alternatives. This is somewhat remarkable, since co-ordination may have its appeal to policy-makers as an "intermediate" choice, that is a choice which may satisfy the advocates of decentralisation as well as those of centralisation by sharing the power between central and local jurisdictions. Second, note, that in principle, we can extend Proposition 2 to cover case 1, if we append the condition that also eq. (25) is satisfied: the superiority of decentralisation will then carry over to the situation in which *L*'s education standard is moderately higher than the national standard.

4. SUMMARY AND CONCLUSIONS

In this paper, we employed a three-period overlapping generation model with non-altruistic households and regional differences to study the effects of three forms of education policy on the sustainability of pay-as-you-go social security. The regions differ in terms of the innate human capital of their

inhabitants: those living in region *L* have lower ability than those living in region *H*. We have argued that, because of this, the regions will have different rates of population growth, and we have identified a set of conditions which ensures that this rate will be larger in *H*. Given this background, we evaluated the impact of centralised, co-ordinated and decentralised education policies on social security. The three policy options differ, in general, in the education standard that they offer and in the way they are funded.

We found that, when both regional education standards equal the national standard, decentralisation makes the pension system more viable, because it encourages fertility more than other policies; then, we extended this result, under conditions concerning the reactivity of wages to changes in educational standards, to the cases in which the low-ability region has a lower standard and the high-ability region a higher standard. Both results depend mostly on how the taxes needed to finance the expenditure on education are allocated among regions, and on how people react to them. We know that more taxes imply less children and, in due course, a less viable PAYG pension system, while a higher education standard has exactly the opposite implications. It is therefore somewhat obvious that the policy design which is best suited to our purpose is the one involving the highest education standard and the lowest tax. What is less obvious is that in general decentralisation is capable of achieving this result by allocating the fiscal burden

in such a way that *both regions, not only one*, are better off in terms of the viability of social security.

In summary, one may view our contribution from two different standpoints. On the one hand, we identified a set of circumstances under which decentralisation in education policy may be useful, using arguments which differ from those provided in the literature; on the other hand, we argued that the sustainability of the pension system can be enhanced also by the decentralisation of education policy, in addition to the usual measures (raising retirement age, increasing labour force participation, favouring immigration and so forth).

APPENDIX

A1. Proof of Claim 1 (sketch)

i) Eq. (23a): straightforward.

ii) Eq. (23b): a few manipulations yield:

$$N(t+1)-N(t)= \\ =\frac{(\hat{n}^H)^{t+1}(\hat{n}^L)^{t+1}\left[(\hat{n}^L)/(\hat{n}^H)+(\hat{n}^H)/(\hat{n}^L)-2\right]}{\left((\hat{n}^H)^{t+1}+(\hat{n}^L)^{t+1}\right)\left((\hat{n}^H)^{t}+(\hat{n}^L)^{t}\right)}. \qquad \text{(A1)}$$

The sign is determined by the term in brackets. It turns out that this term equals $(\hat{n}^L-\hat{n}^H)^2/(\hat{n}^L)(\hat{n}^H)$ and is therefore positive. This establishes eq. (16b).

iii) Eq. (23c): we want to show that, given any ε, there exists a real number τ such that for all $t > \tau$:

$$\left|N(t)-\hat{n}^{H}\right|<\varepsilon\,. \tag{A2}$$

Some tedious algebra shows that (A2) can be rewritten as:

$$\frac{\left|\hat{n}^{L}-\hat{n}^{H}\right|}{\varepsilon}-1=\frac{(\hat{n}^{H})^{t-1}}{(\hat{n}^{L})^{t-1}} \tag{A3}$$

Taking logarithms on both sides and rearranging terms, yields:

$$\frac{\ln\left(\dfrac{\left|\hat{n}^{L}-\hat{n}^{H}\right|}{\varepsilon}-1\right)}{\ln\left(\hat{n}^{L}/\hat{n}^{H}\right)}+1<t \tag{A4}$$

But this solves the problem, as we can just set τ equal to the term on the l.h.s of (A4). Thus, also eq. (23c) is established. QED

NOTE

1. Unless they also choose to make some radical reform. For instance, Börsch-Supan (1998) argues that the adoption of a fully funded scheme will solve the sustainability problem in Germany; Sinn (1997) proposes a partial transition to a funded system. Other contributions to the debate on the transition from pay-as-you-go to funded schemes include Breyer (1989), Homburg (1990), Fenge (1995).
2. As far as social security is concerned, it has been shown that many standard results (e.g. that public pensions reduce savings) do not survive

the shift from exogenous to endogenous fertility (Rosati 1995, Cigno and Rosati 1996); even the celebrated Ricardian equivalence fails with endogenous fertility (Wildasin 1990). On pensions and endogenous fertility see also Nishimura and Zhang (1992, 1995), Peters (1995), Kolmar (1997) and Sinn (1997), among others.

3. On immigration and social security see. among others, Felderer (1992) and Sinn (1997).
4. Other forms of education policy in overlapping generations economies are studied by Cremer *et al*. 1992, Bahram *et al*. 1995 and Balestrino 1997, among others.
5. In a recent contribution, Cigno (1999) shows that the family rules are also negotation-proof.
6. We ignore the physiological upper bound on fertility (*n* must be less than some positive threshold), as we assume throughout that it is non-binding.
7. Endogenous fertility problems are often not well-behaved; in our case, however, with γ strictly convex, intertemporal separability turns out to be sufficient for the second-order condition to be satisfied.
8. Note that the variable *s* does not enter the first order condition for *n*: that is, eq. (5a) alone determines the optimal fertility level. This simplifies matters considerably, as it allows to take the straightforward approach to comparative statics adopted in the text, rather than performing a full analysis.
9. We are assuming that social security and education are managed by separated branches of the government or the region, and that compensations between the budgets are not permitted.
10. This suggests that the type of education policy which is best suited for the purpose of alleviating the social security viability problem, is also politically sustainable: everybody would favour a policy which guarantees a high expenditure with low taxes!