Designing a linear pension scheme with forced savings and wage heterogeneity

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Abstract

This paper studies the optimal linear pension scheme when society consists of rational and myopic individuals. Myopic individuals have, ex ante, a strong preference for the present even though, ex post, they would regret not to have saved enough. While rational and myopic persons share the same ex post intertemporal preferences, only the rational agents make their savings decisions according to these preferences. Individuals are also distinguished by their productivity. The social objective is "paternalistic": the utilitarian welfare function depends on ex post utilities. We examine how the presence of myopic individuals affects both the size of the pension system and the degree of redistribution it operates. The relationship between proportion of myopic individuals and characteristics of the pension system turns out to be much more complex than one would have conjectured. Neither the impact on the level of pensions nor the effect on their redistributive degree are unambiguous. Nevertheless, we show that under some plausible assumptions adding myopic individuals increases the level of pension benefits and leads to a shift from a flat or even targeted scheme to a partially contributory one. However, we also provide an example where the degree of redistribution is not a monotonic function of the proportion of myopic individuals.

Keywords: social security, myopia, dual-self model

JEL classification: H55, D91

1 Introduction

Public pension systems have three main functions. First, they force saving. Some individuals might be inclined to save less than the amount set aside through payroll taxes. Second, they redistribute income. Ideally, redistribution should be implemented by income taxation on a lifetime basis. Unfortunately, such a redistribution is rather limited in practice and, in most countries, pension systems are viewed as an effective and politically sustainable way of redistributing income in old age. Finally, public pensions provide insurance in a number of ways pertaining to health, longevity and financial risks. This paper is concerned with the first two functions, and particularly the first one.

Even though the ideas of time inconsistency, myopia and procrastination and the ensuing need for forced saving have been present in the social security literature for decades, they have not been that popular in formal work. Redistributive considerations and concern for dynamic efficiency have dominated most of the theoretical work on social security. Feldstein (1985) is clearly an exception. His paper examines an overlapping generation economy with inelastic labor supply in which rational and myopic individuals coexist.[1] It analyses the welfare consequence of introducing a mandatory pension system and argues that it may be optimal to have a meager social security system. Feldstein's model was extended by Imrohoroglu *et al.* (2000) who conclude that social security provides additional welfare for myopic agents who may regret their saving decisions when they find themselves with low consumption after retirement. There is also the recent paper by Diamond and Koszegi (2003) which stems from the hyperbolic discounting literature. Social security is there viewed as a commitment device.

The last decade has seen the emergence of behavioral economics which explores the possible conflict between our preferences for the long-run and our short-run behavior. The discrepancy between long-run intentions and short-run action is apparent for a wide range of circumstances and particularly for savings decisions. A number of surveys and experiments point out that a majority of people believe they should be saving more

[1] See also Feldstein (2002), sections 4.1 and 4.2.

for retirement.[2] This evidence suggests that households have self-control problems that call for commitment devices such as a public pension system. Quite interestingly, self-control problems vindicate the idea of a paternalistic role for the government that for long was highly controversial.

In general, the self-control problem we have in mind is dealt with in the framework of hyperbolic preferences. In this paper, we adopt a two-period setting that does not lend itself to such preferences. Like Feldstein we consider a society in which two types of individuals coexist: rational ones who don't have to be forced to save and myopic ones who, *ex ante*, have a strong preference for the present even though, *ex post*, they would regret not to have saved enough. Individuals are also distinguished by their productivity. The government has two objectives: forcing myopic individuals to save enough to support some basic standard of living throughout retirement and redistributing resources from high to low earners.

Designing an optimal pension system where all people are rational or myopic is pretty straightforward. The difficulty comes from mixing the two types and from mixing the objectives of forced saving and income redistribution.

We adopt a rather simple framework, namely a *linear scheme* with a payroll tax with uniform rate and pension benefits that have a contributory (Bismarckian) part and a flat rate (Beveridgean) part.[3] To keep the model simple, we assume that the same distribution of productivity prevails in the two groups. The objective of the social planner is a utilitarian but paternalistic criterion. To be more precise, we consider the sum of individual utilities in which both rational and myopic individuals are given the same rate of time preference, namely that of the rational individuals.

Anticipating on the results, we reach a number of conclusions. Focusing first on homogeneous societies, the reason for a public pension system when all individuals are rational is just redistribution. What matters then is wage inequality along with some preference for equality. When all individuals are myopic, the main rationale for a pension system is to secure some level of resources in the retirement period. The extent

[2] For a survey, see Angeletos *et al.* (2001).

[3] The non linear case is studied in a companion paper (Cremer *et al.* 2006a).

of this concern depends on the concavity of the utility function. Quite surprisingly, the comparison of pension levels between an all rational and an all myopic society does not appear to be unambiguous. Redistribution plays also some role. Should the pension system be Bismarckian or Beveridgean? With only rational individuals, a pure Beveridgean system is desirable when liquidity constraints are assumed away. In the case they are not, some targeting towards the poor is desirable. With only myopic individuals, the Beveridgean formula always prevails.

When the two types, rational and myopic households, are combined, the payroll tax will mainly depend on three factors: wage inequality, concavity of the utility function and labor supply elasticity. Whether the pension system departs from the Beveridgean system and in what direction is not obvious.

2 The model

Rational individuals' utility is given by

$$U_R = u(c - v(\ell)) + u(d), \tag{1}$$

where c and d are first- and second-period consumption, ℓ is first-period labor supply, $v(\ell)$ is the disutility from working and $u(.)$ is the instantaneous utility from consumption, net of labor supply disutility. We assume that $u'(.) > 0$, $u''(.) < 0$, $v'(\ell) > 0$, $v''(\ell) > 0$. In the second period, individuals are retired. This utility (1) is also that of myopic individuals *ex post*. *Ex ante*, myopic agents totally forgo the second period and their utility is given by

$$U_M = u(c - v(\ell)).$$

Individuals also differ in productivity $w \in [w_-, w_+]$. The distribution of w, represented by the distribution function $F(.)$, is independent of the proportions π_R and $\pi_M = 1 - \pi_R$ of rational and myopic individuals in the population.[4]

In the absence of a pension system, rational individuals choose c, d and ℓ to maximize

$$u(c - v(\ell)) + u(d).$$

[4] In other words, the distribution of productivities is the same for the two types.

We suppose a zero interest rate (and zero rate of population growth), so that $c+d=w\ell$.

For the myopic individuals, the problem is even simpler; they choose the value of ℓ that maximizes:

$$u\left(w\ell - v(\ell)\right).$$

We now introduce a pension system consisting of a payroll tax τ and pension benefits p that are given by

$$p = \tau\alpha w\ell + \tau(1-\alpha)Ew\ell.$$

Here and throughout the paper the notation Ez, where z is any function of w, is used for its average value:

$$Ez = \int_{w_-}^{w_+} z\left(w\right)dF\left(w\right).$$

The parameter α is often called the Bismarckian or the contributory factor. When $\alpha = 0$, $p = \tau Ew\ell$ and we have a flat benefit or (Beveridgean) pension system; all individuals receive the same pension irrespective of their contributions. When $\alpha = 1$, $p = \tau w\ell$ and we have a purely contributory (Bismarckian) system; individuals' pensions are proportional to their contributions. If $\alpha < 0$, pension benefits are inversely related to the wage level and we have a targeted pension system. In most countries, α is between 0 and 1.

The problem of rational individuals is given by

$$\begin{aligned} &\max_{c,d,s,l} u(c - v(\ell)) + u(d), \\ &\text{s.t. } c + s \leq (1-\tau)w\ell, \\ &\quad d \leq s + \tau\alpha w\ell + \tau(1-\alpha)Ew\ell. \end{aligned}$$

Let $x = c - v(\ell)$ denote the value of net consumption in period 1. We distinguish two cases depending on whether or not liquidity constraints are imposed.

When there are no liquidity constraints, s can be negative and we have:

$$\begin{aligned} u'(x_R) &= u'(d_R), \\ v'(\ell_R) &= (1-\tau(1-\alpha))w. \end{aligned} \tag{2}$$

Equation (2) yields the labor supply function: $\ell_R = \ell\left(w\left(1-\tau\left(1-\alpha\right)\right)\right)$. Labor supply increases with productivity w and with the Bismarckian parameter α, and decreases with the contribution rate τ.

With liquidity constraints, $s \geqslant 0$. If $s > 0$, we have the above first-order conditions. If, however, $(1-\tau)wl_R - v(\ell_R) < \tau\alpha w\ell_R + (1-\alpha)Ew\ell$, $s = 0$ and we have:

$$\begin{aligned} &u'(x_R) > u'(d_R), \\ &v'(l_R) = (1-\tau)w + \frac{u'(d_R)}{u'(x_R)}\tau\alpha w, \end{aligned} \tag{3}$$

with

$$\begin{aligned} x_R &= (1-\tau)w\ell_R - v(\ell_R), \\ d_R &= \tau\alpha w\ell_R + (1-\alpha)\tau Ewl. \end{aligned}$$

Consequently, labor supply depends on w, τ, α for all rational individuals, and also on $Ew\ell$ for those rational agents who are liquidity constrained.

Turning to the myopic agent, his problem is simply to maximize

$$u\left(\left(1-\tau\right)w\ell - v\left(\ell\right)\right),$$

which yields

$$v'\left(\ell_M\right) = \left(1-\tau\right)w$$

with

$$\begin{aligned} x_M &= (1-\tau)wl_M - v(l_M), \\ d_M &= \tau\alpha wl_M + (1-\alpha)\tau Ewl. \end{aligned}$$

We thus obtain $\ell_M = \ell\left(w\left(1-\tau\right)\right)$.

Note that if $\alpha = 0$, labor supply is identical in each of the three cases, as it depends only on $w\left(1-\tau\right)$. This is due to the fact that we have assumed away income effects. We shall distinguish cases according to whether or not savings can be negative. When there is no liquidity constraint, savings can be negative. Saving might also be positive for all rational agents, which is the case when pension benefits are low because, e.g., distortions are very high. When savings are strictly positive for all rational agents, we have $u'(x_R) = u'(d_R)$. Furthermore, given our assumptions we have $u'(x_M) < u'(d_M)$ for all myopic individuals. In other words, all myopic individuals, even the poor, consume more in the first than in the second period. We use this result below.

3 Government's problem

We now consider the problem of a social planner dealing with a society of rational and myopic individuals with different productivities. Its objective is the sum of ex post individual utilities, represented by the same utility functions for rational and myopic individuals. The idea is that *ex post* the myopic will be grateful to their government for having forced them to save.

Using our compact notation, the problem of the social planner is expressed as follows:

$$\begin{aligned}\mathcal{L} &= \sum_{j=M,R} \pi_j \left\{ Eu[w(1-\tau)\ell_j - s_j - v(\ell_j)] \right. \\ &\quad \left. + Eu\left[s_j + \tau\left(\alpha w\ell_j + (1-\alpha) Ew\ell\right)\right]\right\},\end{aligned}$$

Differentiating this expression yields:

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial \tau} &= -\sum \pi_j \left\{ E\left[w\ell_j\left(u'(x_j) - \alpha u'(d_j)\right) - u'(d_j)(1-\alpha) Ew\ell\right]\right\} \\ &\quad + \pi_M \tau \alpha E\left[w\frac{\partial \ell_M}{\partial \tau} u'(d_M)\right] + \sum \pi_j Eu'(d_j)\tau(1-\alpha) Ew\frac{\partial \ell_j}{\partial \tau}, \qquad (4)\\ \frac{\partial \mathcal{L}}{\partial \alpha} &= \sum \pi_j \left\{ \tau \ \operatorname{cov}\left(w\ell_j, u'(d_j)\right) + (1-\alpha)\tau Eu'(d_j) E\left(w\frac{\partial \ell_j}{\partial \alpha}\right)\right\}. \qquad (5)\end{aligned}$$

3.1 Optimal tax rate

We first focus on the optimal tax rate for a given α. Rearranging (4) we obtain,

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial \tau} &= -\sum \pi_j \left\{ (1-\alpha)\operatorname{cov}[w\ell_j, u'(d_j)] - E[w\ell_j(u'(d_j) - u'(x_j))]\right\} \\ &\quad + \sum \pi_j (1-\alpha)\tau E[u'(d_j)] E\left[w\frac{\partial \ell_j}{\partial \tau}\right] + \pi_M \tau \alpha E\left[w\frac{\partial \ell_M}{\partial \tau} u'(d_M)\right]. \qquad (6)\end{aligned}$$

Setting this expression equal to zero and solving yields:

$$\tau = \frac{\sum \pi_j [(1-\alpha)\operatorname{cov}(w\ell_j, u'(d_j))] - \sum \pi_j E\left[w\ell_j\left(u'(d_j) - u'(x_j)\right)\right]}{\sum \pi_j (1-\alpha) Eu'(d_j) E\left(w\frac{\partial \ell_j}{\partial \tau}\right) + \pi_M \alpha E\left(w\frac{\partial \ell_M}{\partial \tau} u'(d_M)\right)}. \qquad (7)$$

The two terms in the denominator reflect the efficiency concern and depend on the tax elasticity of labor supply, which is negative. The first term, which relates to the non contributory part of the pension scheme for all agents, is standard. The second term focuses on the contributory part for the myopic individuals only, since unlike rational agents they fail to factor in the link between pensions and contributions when choosing how much labor to supply. The two terms that compose the numerator reflect the equity concerns. The covariance term represents the redistributive objective: this term is usually negative as the level of earnings and the marginal utility of second period consumption are negatively correlated. The second term, which we call consumption smoothing, comes from the desire to secure enough consumption for all individuals in both periods. To get a better grasp at its impact, assume that we are in a case where saving is positive for all rational agents. In that case, $d_M < x_M$ for all myopic agents, so that the consumption smoothing term calls for a higher tax rate in order to decrease the consumption gap between the two periods for the myopic individuals. On the other hand, if the non negative saving constraint is binding for some rational agents, the consumption smoothing term for them would call for a lower payroll tax rate in order to increase their first period consumption.

Equation (7) shows that the impact on the optimal contribution rate of having myopic individuals in society is complex. One can identify *four* effects. First, the difference between first and second period consumption is larger for myopic than for rational agents of same productivity, so that the consumption smoothing term calls for a higher payroll tax. This effect corresponds to the intuition that the payroll tax should be higher with myopic individuals to compensate for their second period consumption being too low. However, the other three effects go in the opposite direction. Myopic individuals save less than rational agents, which tends to reduce the absolute value of the (negative) covariance term in the numerator of (7), this calls for a lower τ. The third effect goes in the same direction: with myopic individuals, the contributory part of the pension scheme generates labor supply distortions, which in turn call for a lower payroll tax.[5] Finally, the marginal utility of second period consumption is larger for

[5] Recall that there is no such distortion for rational individuals because they anticipate the induced

myopic than for rational agents of same productivity, which increases the distortionary impact of the Beveridgean part of the pension scheme and also calls for a lower payroll tax. The net effect of the presence of myopic individuals can of course not be assessed by *counting* the terms that go one way or the other. The crucial factor is their magnitude which cannot be assessed at this level of generality. The numerical examples given below show that the initial intuition may well go through in spite of the presence of the countervailing effects.

When we compare the extreme settings of $\pi_M = 0$ (no myopic individuals) and $\pi_M = 1$ (all myopic society) the expression is simplified but remains ambiguous. To see this most clearly we make two additional simplifying assumptions, namely $s_R > 0$ and $\alpha = 0$. The assumption that $s_R > 0$ means that all myopic agents should have saved, which translates in a consumption smoothing term that is nil for rational agents and positive for myopic individuals. The assumption that $\alpha = 0$ means that we concentrate on a Beveridgean system, assuming away the distortion generated by the contributory part of the pension system on myopic individuals' labor supply. The optimal payroll tax with rational agents only is then given by:

$$\tau^R = \frac{-\operatorname{cov}\left(w\ell_R, u'\left(d_R\right)\right)}{-Eu'\left(d_R\right) E\left(w\dfrac{\partial \ell_R}{\partial \tau}\right)}. \tag{8}$$

With myopic individuals only we have

$$\tau^M = \frac{-E[w\ell_M\left(u'\left(d_M\right) - u'\left(x_M\right)\right)]}{u'\left(d_M\right) E\left(w\dfrac{\partial \ell_M}{\partial \tau}\right)}, \tag{9}$$

Comparing to the general expression (7), we can notice that the numerator of the expression for τ^R does not contain the consumption smoothing term while the numerator of τ^M has no covariance term (with $\alpha = 0$, d_M is the same for all so that $\operatorname{cov}\left(w\ell_M, u'\left(d_M\right)\right) = 0$). In spite of these simplifications the comparisons between the numerators in the expression for τ^R and τ^M remains ambiguous. The denominator, on the other hand can be expected to be larger with myopic individuals. This corresponds to the fourth effect identified in the discussion of the general expression.

increase in pensions.

Summing up, the net effect of the presence of myopic individuals on the optimal tax rate appears to be ambiguous. The numerical examples presented below suggest that the consumption smoothing term appears to dominate in a wide range of settings. However, our examples are purely illustrative; the precise comparison remains an empirical question that requires at the very least simulations based on a calibrated version of the model.

3.2 The optimal value of the Bismarckian factor

The first order condition in equation (5) trades off the anti-redistributive impact of α (which increases consumption inequality, as measured in the first term) with its efficiency-enhancing effect on the labor supply of rational individuals (the second term reduces to $\pi_R (1-\alpha) \tau E u' (d_R) E (w \partial \ell_R / \partial \alpha) > 0$ as $\partial \ell_M / \partial \alpha = 0$).

To better understand the implications of equation (5) for the optimal α, we cover successively the cases where society is composed of myopic agents only, of rational agents only, and of both types of agents.

When society is composed only of myopic individuals, equation (5) simplifies to

$$\frac{\partial \mathcal{L}}{\partial \alpha} = \tau \ \operatorname{cov} \left(w \ell_M, u' (d_M) \right),$$

which is zero when $\alpha = 0$: with a flat pension $d_M = p$ is constant for all w so that the covariance is equal to zero. Furthermore, when $\alpha > 0$ the covariance is negative, while it is positive when $\alpha < 0$. Consequently, the optimal level of α, denoted by α^M is zero. Intuitively, with only myopic agents there is no (efficiency) reason to link pension benefits to contributions, and the social planner's redistributive objective leads to the adoption of a Beveridgean scheme.

We now look at a society composed exclusively of rational agents. Setting (6) equal to zero and substituting in (5) yields

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial \alpha} &= \frac{1}{1-\alpha} E w \ell_R \left(u' (d_R) - u' (x_R) \right) \\ &\quad + E u' (d_R) E \left[w \left(\frac{\partial \ell_R}{\partial \tau} \tau + \frac{\partial \ell_R}{\partial \alpha} (1-\alpha) \right) \right]. \end{aligned} \tag{10}$$

In the absence of liquidity constraint (or with $s_R > 0$) the first term in (10) vanishes. Observe that, by equation (2), the labor supply of non liquidity constrained rational individuals is a function of $\tau(1-\alpha)$. It follows that the second term in (10) vanishes also. Furthermore, only the optimal value of $\tau^R\left(1-\alpha^R\right)$ matters and thus there is no single optimal value of α^R. To be more precise, the optimal combinations of τ^R and α^R are defined by the equation $\tau^R\left(1-\alpha^R\right) = \tau^*$, when τ^* is the optimal tax rate conditional on $\alpha = 0$. Intuitively, with non liquidity constrained rational agents, the payroll tax and the Bismarckian parameter are perfect substitutes. Their optimal combinations trade off redistribution and the labor supply distortions generated by the non contributory part of the pension system.

We now assume that some rational individuals are liquidity constrained. For those individuals (low-wage earners), $d_R > x_R$ and

$$\frac{\partial \ell_R}{\partial \tau}\tau + \frac{\partial \ell_R}{\partial \alpha}(1-\alpha) < 0$$

by virtue of (3), so that both terms in (10) are negative. The perfect substitutability between τ and α then disappears when some rational agents are liquidity constrained, and the optimal value of α becomes negative. The intuition for this result is that introducing targeting into the pension system (by means of a negative value of α) has nice redistributive properties while being less damaging to efficiency than in the no liquidity constraint case, since the sensitivity of labor supply to variations of α is dampened by the lower relative utility of second period consumption.

Finally, when both myopic and rational agents coexist, one can show that

$$\left.\frac{\partial \mathcal{L}}{\partial \alpha}\right|_{\alpha=0} = \pi_R \ \operatorname{cov}\left(w\ell_R, u'(d_R)\right) + \pi_R E u'(d_R)\, E w \frac{\partial \ell_R}{\partial \alpha}.$$

The first term of the right hand side is negative but the second one is positive and thus we cannot sign this expression.

To sum up the main conclusions of this section, we show that τ^M is likely to be larger than τ^R particularly when the rational individuals are not liquidity constrained. We also show that α^R is determined by $\tau^R\left(1-\alpha^R\right) = \tau^*$ when rational agents are not liquidity constrained. When they are, α^R can be negative. As to α^M it is zero. The sign of the optimal value of α is ambiguous when both rational and myopic individuals coexist.

π^R	α	τ	τ^*
0.0	0.000	0.250	0.250
0.1	0.066	0.247	0.247
0.2	0.122	0.245	0.243
0.3	0.169	0.243	0.239
0.4	0.209	0.242	0.233
0.5	0.243	0.240	0.227
0.6	0.272	0.239	0.220
0.7	0.298	0.238	0.211
0.8	0.321	0.237	0.209
0.9	0.342	0.236	0.209
1.0	-	-	0.151

Table 1: Optimal linear pension scheme as a function of the proportion of rational individuals. No liquidity constraint. We denote τ^* the optimal tax rate for $\alpha = 0$.

In view of such an ambiguity, we now turn to a numerical example in the next section to illustrate our findings.

4 Numerical example

Our numerical simulations are based on the following utility function,

$$u = \log\left(c - \ell^2/2\right) + \log d$$

and a positively Beta$(2, 4)$ distribution for the wages with support $(1, 4)$. Table 1 presents the optimal value of α and τ for alternative values of the proportion of rational individuals, π^R. It also gives the optimal values of τ when $\alpha = 0$, which we denote by τ^*. In calculating these values, we assume away any liquidity constraint so that the poor rational individuals exhibit negative savings. Table 2 presents the same results for the case where liquidity constraints are imposed.

We start with Table 1. We know from theory that the optimal value of α is zero in the absence of rational individuals, and that τ and α are perfectly substitutable when society is composed only of non liquidity constrained individuals. The optimal value of $\tau(1-\alpha)$ when $\pi^R = 1$ is given by τ^*. The comparison between the optimal Beveridgean payroll tax when there are only rational individuals who save and when there are only myopic individuals is in general ambiguous, although we conjectured that it would be larger with myopic individuals. This conjecture is borne out by the results reported in Table 1.[6]

Remember that the optimal payroll tax rate trades off four concerns, two of them in favor of a large tax (redistribution and consumption smoothing) while two of them plead for a low tax (labor supply effects of the non contributory part of pension for all individuals, and of the contributory part for myopic agents). The presence of myopic agents tends to increase both the redistribution and the consumption smoothing effects while also making the Bismarckian part of the insurance package distortionary. Assuming that the pension system is Beveridgean ($\alpha = 0$), it seems reasonable to surmise that the optimal payroll tax increases with the proportion of myopic agents, which is the result we obtain in Table 1 by looking at the τ^* column. Moreover, the optimal value of τ (obtained by optimizing simultaneously over τ and α) is also increasing with the proportion of myopic individuals.

The optimum value of α trades off redistribution (calling for moving away from a Bismarckian system towards a Beveridgean or even a targeted system) and efficiency (calling for a tighter link between pension benefits and contributions). Since a Bismarckian system fares no better, in efficiency terms, than a Beveridgean one for myopic individuals, intuition suggests that the optimal system would be more and more Beveridgean as the proportion of myopic individuals increases, i.e. that the optimal value of α should increase with π^R. This is what we obtain in Table 1.

We now turn to Table 2. We know from theory that the optimal value of α is zero in the absence of rational individuals, and is negative when society is composed only of rational individuals, some of them being liquidity constrained. Comparison of Tables 1 and 2 shows that when all individuals are rational the optimal value of $\tau(1 - \alpha)$ is smaller when a liquidity constraint is imposed on the rational individuals than when

[6] The situation we simulate in Table 1 is slightly different, since even though all rational agents equalize marginal utility in both periods, the lowest earners do so by borrowing rather than saving. This means that, although the consumption smoothing term $u'(d_R) - u'(x_R)$ in (7) is nil for all rational agents, it is negative for low productivity myopic agents and positive for the other myopic individuals. It is nevertheless reasonable to assume that, on average, the consumption smoothing term is positive for myopic agents.

there is no liquidity constraint. This is because when there is a liquidity constraint the higher tax has a more significant effect on the first period consumption of the poor (who benefit from the redistribution, but only in the second period). When all individual are myopic, on the other hand, the liquidity constraint imposed on the rational individuals is of course irrelevant; this explains why the level of α^* for $\pi^R = 0$ is the same in both tables. We also obtain from Table 2 that the optimal payroll tax when $\alpha = 0$ is larger when there are only rational individuals than when there are only myopic individuals. In other words, the fact that some rational agents are credit constrained and exhibit a negative consumption smoothing term is not enough to reverse the relationship we obtain from theory when all rational agents exhibit positive savings. On the other hand, by comparing the last columns of Tables 1 and 2, it is clear that this consumption smoothing effect leads to a lower optimal tax rate (conditional on $\alpha = 0$), when credit constraints are imposed than when they are not.

We also obtain, in Table 2 as in Table 1, that the optimal payroll tax rate (both when α is set at zero and when it is also optimized) decreases monotonically with π^R. The main difference between the two Tables lies in the behavior of the optimal α with respect to the proportion of myopic agents. When some rational individuals are liquidity constrained, the optimal α first rises then decreases with π^R. The largest optimal non contributory part of the pension system is obtained when 30% of the population consists of myopic individuals, and decreases as one moves away from that proportion.

5 Conclusion

In this paper, we have analyzed the linear pension schemes that ought to be applied in a society wherein myopic and rational agents coexist and the government forces the former to save. The foundation of such a paternalistic behavior lies in the fact that myopic individuals will be grateful in the second period of their life to the government for having forced them to save for their old age. In other words, myopic agents have two selves, one looking for immediate gratification and one looking for long term welfare in the tradition of "dual-self" models (see, e.g., O'Donoghue and Rabin (2001)).

We show that introducing that type of agents in a society of rational individuals has

π^R	α	τ	τ^*
0.0000	0.000	0.250	0.250
0.1000	0.072	0.246	0.245
0.2000	0.131	0.243	0.240
0.4000	0.220	0.236	0.228
0.6000	0.277	0.230	0.213
0.7000	0.295	0.225	0.203
0.9000	0.290	0.209	0.191
0.9100	0.281	0.206	0.172
0.9300	0.269	0.202	0.168
0.9600	0.232	0.192	0.160
0.9900	0.106	0.166	0.151
0.9990	-0.184	0.127	0.148
0.9999	-0.346	0.111	0.147
1.0000	-1.360	0.064	0.147

Table 2: Optimal linear pension scheme as a function of the proportion of rational individuals. Liquidity constraint

implications for the level of pension benefits and the redistributiveness of the system that are far more complex than one would have expected. Intuitively one expects that adding myopic individuals increases the level of pension benefits and leads to a less redistributive system. We show that this intuition goes through under some conditions. Specifically, the presence of myopic individuals may even induce a shift from a targeted scheme to a partially contributory one. However, no definitive results can be obtained in a general setting and the assessment of net effect appears to be an empirical question.

To keep the analysis simple, we have restricted the pension system to a linear scheme and we have assumed that the rate of return and the rate of population growth were not only the same but equal to zero. Relaxing the latter assumption would not change the qualitative nature of our results. Allowing for a non linear scheme is likely to have strong implications depending on informational assumptions, as we show in a companion paper (Cremer *et al.* (2006a).

This paper is normative; a paternalistic social planner designs an optimal pension system, optimal from an *ex post* standpoint for the myopic individuals. In Cremer *et al.* (2006b), we have also analyzed the political economy aspect of the same problem wherein individuals, myopic and rational, vote *ex ante* for a pension system. We there assume that the myopic, when they vote, are in a kind of "state of grace", which makes them choose a commitment device. Interestingly, we obtain results that are parallel to those found in this paper: the introduction of myopic agents increases the generosity and decreases the redistributiveness of the pension system.

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