Workers' Choice on Pension Schemes: an Assessment of the Italian TFR Reform Through Theory and Simulations

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Abstract

In this paper we aim at providing a theoretical framework to model workers' choice problem of switching between different pension schemes. This choice problem is common in several countries that have reformed their social security system in the last decades. Although with some specific features, such process is currently affecting private sector employees in Italy, since the reform of the TFR mechanism in 2007. This reform basically allows workers to choose between a scheme directly managed by the firms and an external defined contribution scheme. In their decision workers not only have to weight out the different pros and cons that different schemes offer but they also have to consider the effect that their choice exerts on the financial structure of the firm they work in. Once we have formalized this decision problem, we carry out some simulations in order to replicate the Italian data and to shed some light on the outcomes of the Italian reform.

1 Introduction

In the last twenty years changes in the demographic structure and in the growth expectations have induced many countries to reform their Social Security System (SSS). One of the most common features of these reforms is the shift from a defined benefit scheme (DB) to a defined contribution scheme (DC). According to the DB scheme, pensions mostly depend on past wages, length of services and possibly on the expected length of the retirement period, whereas according to the DC scheme, they depend on the contributions paid, on the performance of pension funds (PF) where

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contributions are invested and on the length of the retirement period. Some countries have also introduced notional contribution scheme (NDC) where the pensions are financed through a PAYG scheme and are computed out of contributions paid which are revalued at a given rate not depending on the performance of funds but on some macroeconomic variables. While DB schemes are still common, new reforms introduced DC or NDC in several OECD countries: in particular Australia, Hungary, Mexico and Slovak Republic have switched to some form of DC scheme, while Italy, Poland and Sweden introduced NDC schemes. Similar reforms were also implemented in South America, with DC schemes replacing DB schemes: Chile was the first one in 1981 and 10 more countries followed in the late nineties. Depending on the country, these switches to the new schemes were partial or complete, voluntary or mandatory (for further details see Whiteford and Whitehouse 2006 for OECD countries and Mesa-Lago 2006 for Latin America). To all extents, many workers in these countries had the possibility to opt for complementary social security (CSS) investing thus in a PF, either as a substitute or complement of the publicly granted pension.

1.1 The Italian experience

The situation in Italy is not an exception: here the SSS will hardly be able to grant adequate pension benefits to the current generations of young workers, in particular temporary workers, and after the 1990's reforms that transformed the PAYG Italian SSS from a DB to a NDC scheme, the replacement rate between pension and last wage of private sector employees will decrease from current 70-80% to less favourable levels ranging between 55% and 79%, depending on both the working career length and the retirement age (see Table A.1, Appendix A). In order to cope with this issue, since the first reform of SSS in 1993 several laws have been introduced to strengthen the CSS[1] which, however, has remained undersized, both in absolute terms and compared to the rest of developed countries (3.5% of GDP in 2006, see Table A.2 in Appendix A).

Given the relatively poor results of previous attempts, a reform was conceived in 2004 and implemented in 2007 in order to boost CSS for private sector employees. Such reform affected the pre-existing termination indemnity payments (TFR) scheme, according to which a part of workers' wage is withheld by the employer and given back, revaluated at a certain rate, upon retirement or, in any case, upon job termination; in many respects the TFR resembles a mandatory DB scheme, with contributions withheld and managed directly by the employer. The 2007 reform revised the mandatory nature of this scheme and allowed workers to invest the contributions to

[1]For example, D.lgs. 124/93, l. 335/95, D.M. 703/96, D.P.C.M. 20/12/1999 (modified by D.P.C.M. 26/02/2001), D.lgs. 47/2000, legge delega 243/2004, il D.lgs. 252/2005 e law 296/2006.

the TFR in the second pillar system through the principle of silent or implied consent and the provision of substantial fiscal incentives. The switch from TFR to CSS is irreversible, while the choice of remaining at the TFR scheme can be reconsidered in any future period (see section 4.1 for a deeper description of the 2007 reform).

However, two years after the introduction of this reform, the observed adhesion rates to CSS remain astonishingly low (only 26% of potential private sector subscribers by the end of 2008 according to official data). Certainly these low figures may be due to transitory effects, given the recent negative performances of financial markets and to the lack of information among employees; however there might be also a permanent component at work, whose evidence is given by another stylized fact of the adhesion pattern in Italy, i.e. *adhesion rates are positively correlated with firms' size.* If we consider that about 54% of the Italian labour force is employed in firms with less than 50 workers, the persistence of this stylized fact would imply that a great part of the labour force will not switch to the newly introduced scheme, thus casting doubts on the long run effectiveness of the reform.

The 2007 Italian reform has been analyzed by some authors, though a full assessment is still to be done[2]. This literature, although effective in highlighting some aspects of the problem, has not provided a general model capable of rationalizing at the same time the aggregate outcomes of the reform and the clear relation between firm size and adhesion rates to PF.

1.2 The theoretical framework and related literature

In this paper we start from this empirical evidence and we try to give a possible explanation by modeling explicitly the decision process behind workers' choice, bringing to light the determinants of the choice to opt for a new pension scheme[3]. Indeed the problem is only in part a classical case of choice under uncertainty, but it is further complicated by two aspects that are peculiar to the situation at hand: (a) the choice to switch from TFR to PF is an irreversible one and (b) the decision has potentially relevant

[2]In particular, on the workers' side, Cozzolino and Di Nicola (2006) report data on the intentions of workers about the reform and show that a large share of workers were not willing to switch and not perfectly informed. Cesari et al. (2007) try to quantify the economic incentives provided by the reform to adhere to CSS and place emphasis not only on the fiscal rebates, but also on the presence of the "employer contribution". On the firms' size, Bardazzi and Pazienza (2005) carry out simulations aiming at estimating the cost of the reform for Italian firms and Calcagno et al. (2007) argue that the reform will reduce the aggregate investment by medium-small enterprises, since it will reduce the access to credit for some of them, and particularly for smaller firms (a view confirmed also in Pazienza (1997) and Guiso (2003)).

[3]The literature on this point is rather thin, though much effort has been devoted to the anaysis of the characteristics of the different pension schemes; for an overview of the latter subject see Barr (2006) and Barr and Diamond (2006). A more analytical treatment can be found in Blake (2006 and 2006a).

consequences also for the firms. As to (b) we notice that the availability of the TFR stock might have both negative and positive effects on firms: on one side it generates a sort of firing cost similar to a severance payment (in fact a fired worker takes away from the firm the amount he has invested)[4], but on the other, it also supplies a source of credit and liquidity should the need arise. Hence, the decision of workers is a complex one, as they realize that their (irreversible) choice of adhering to an external PF affects their future career also through the cost/benefit they induce on the firms they are currently (and will be) employed in.

As to point (a) above, the literature is still embryonic, with some partial exceptions. Bulow (1982) discusses workers' and firms' incentives for the creation of a corporate pension plan and tries to assess whether this can be seen as a form of implicit contract; Rauh (2006) analyzes the effect of a corporate PF on the internal financial resources and on the core business investments; Rauh (2009) focuses on how a corporate PF might influence the financial investment strategy of firms. However these articles are not interested in and do not introduce the choice problem of workers nor the role of their investment inside the firm as a source of credit and liquidity, something that is central in our paper.

More in detail, we model the decision problem that workers face, having to choose, once and for all, between a safe (the TFR) and a risky (the PF) asset. The key point of our work is that, upon taking this decision, the agent will trade off not only the advantages and disadvantages of higher but riskier returns provided by CSS relative to TFR, but also the "external effects" of his decision on the financial health of the firm in which he is employed in. Indeed, in our model firms can, in case of need, finance themselves through three different channels: (1) the TFR stock (if any) available inside the firm (2) the share (or the very entrepreneurs') capital and, finally, (3) the credit market. Given that we assume some imperfections in the capital market and frictions in the labour market, the choice of an individual to switch from TFR to CSS induces a damage to the financial solidity of the firm and thus, a higher risk of unemployment. Moreover, such an external effect (which we can interpret as a lack of coordination among workers) will turn out to be higher the lower the number of workers employed by the firm and, hence, will be almost negligible for workers employed in large firms: the dimension of firms plays a crucial role in the worker decision.

The work is organized as follows: first we lay out the baseline theoretical framework in order to determine the economic incentives according to which individuals decide whether to adhere or not to CSS. Next, after sketching the institutional setting of the Italian CSS system and the 2007 reform, we

[4]This aspect has been investigated in Garibaldi and Pacelli (2008) where the emergence of firing costs due to the TFR is confirmed: the authors also argue that the 2007 reform will increase the probability of job termination for workers adhering to CSS. Moreover, their data show that this outcome is less likely the larger the firm is.

complicate the analysis and simulate the above model to replicate the main features of the Italian experience as well as to provide some insights on its future outcomes.

2 Basic model

The aim of this section is to build a general model to formalize workers' choice between different pension schemes with possibly different returns: (i) a safe return scheme of contributions inside the firm (called TFR or T henceforth) or (ii) a DC scheme of contributions external to it (called PF or F henceforth). The key point is that we explicitly take into account the effects that the choice of either of them may have on the financial structure of the firm with consequences on workers' labour career[5].

2.1 The framework

We imagine an economy populated by identical agents and firms. All firms employ the same number of workers, N, (N wiil be taken as a measure of the size of the firm) and use the same technology for the production of a commodity Y (the numeraire) in a regime of perfect long run competition. To do that, they hire workers and pay them a gross wage w. Furthermore the pay out dividends to the owners of the capital stock available within the firm. Their production activity is subject to exogenous random shocks.

Agents can be in either of two possible states: they can be employed in one of the above firms in which case they receive the wage w or they are unemployed, in which case they receive a unemployment subsidy that is expressed as a fraction b of the gross wage w. In either case they are bound to invest an amount $\gamma \cdot w < b \cdot w$ into a contribution scheme that is either a safe return scheme directly managed by the firm (T) or a F scheme external to the firm.[6] The amount contributed is the same, but returns are different: a sure return r in the case of T and an uncertain return ρ in the case of F. In the rest we shall assume that $\bar{\rho} = E\rho > r$. In either state, what is not invested in a contribution scheme is immediately consumed.

2.2 Firms' characteristics and endogenous separation

Each firm employs capital K and N workers and hence the total wage bill for it is $N \cdot w$. Each worker enrolled in the T scheme keeps (and has kept) the

[5]As anticipated in the Introduction, this model was conceived to fit the Italian case, but it can be easily generalized to describe different cases.

[6]The hypothesis that an agent continues to pay the contribution also when unemployed is not essential to the theoretical part; it is made only for simplicity purposes and can be justified imagining that the agents keep contributing even in the state of unemployment; clearly, in the case of TFR, this tantamounts to say that the contribution is invested into a safe asset yielding the same returns as the TFR scheme.

contribution $\gamma \cdot w$ inside the firm; if we denote by κ the number of periods that this type of worker were employed in the firm, we have that the actualized stock of his contributions, managed within the firm, is $\kappa \cdot \gamma \cdot w \cdot \frac{(1+r)^t - 1}{r}$ or more simply $\mathbf{k} \cdot \gamma \cdot w$, where $\mathbf{k} = \kappa \cdot \frac{(1+r)^t - 1}{r}$. If we denote by s the share of workers enrolled in the F scheme (supposedly identical in all firms) we have that the total stock of contributions available within the firm is $(1 - s) \cdot N \cdot \mathbf{k} \cdot \gamma \cdot w$. Finally, the amount of capital is expressed as a proportion of the total wage bill, i.e. $K = h \cdot N \cdot w$.

The structure of profits Given the above characteristics, firms' total costs are given by two components: the total wage bill $N \cdot w$ and the remuneration of the capital stock: if we define ι as the rate at which capital is remunerated, the latter component amounts to $h \cdot N \cdot w \cdot \iota$. In fact also the amount $(1 - s) \cdot N \cdot \mathbf{k} \cdot \gamma \cdot w$ should be taken into account since its remuneration at the rate r is a cost for the firm but, for simplicity purposes and without loss of generality, we assume that this stock is invested by the firm, yielding the same remuneration as the T rate, so that the cost for the firm is actually null[7]. Under these assumptions, firm's profits are given by the following expression:

$$\Pi = Y - N \cdot w \cdot (1 + h \cdot \iota) \tag{1}$$

where Y is total production. If we define $\pi = \frac{\Pi}{N}$ as the profit per unit of labour and $y = \frac{Y}{N}$ as the average product of labour, equation (1) can be rewritten as

$$\pi = y - w \cdot (1 + h \cdot \iota)\,. \tag{1a}$$

External shocks on productivity We assume that the productivity of a firm y is a stochastic variable[8] drawn from a distribution with mean $w \cdot (1 + h \cdot \iota)$, i.e. we assume that expected profits are zero, and with a cumulative distribution function $\Psi(y)$. Therefore with a probability of $\frac{1}{2}$ production activity will result in a loss; however we assume that losses can be borne by a firm first by not paying out dividends and then resorting to the credit market where it will receive credit within the limits of the collaterals that it can provide to the banks: we assume that the collaterals are the assets available within the firm, i.e. $N \cdot w \cdot (h + (1 - s) \cdot \mathbf{k} \cdot \gamma)$. Under these assumptions a firm goes bankrupt if only if

$$\pi < -w \cdot [\gamma \cdot \mathbf{k} \cdot (1 - s) \cdot (1 + r) + h \cdot (1 + \iota)] \tag{2}$$

[7]We justify the presence of different interest rates with the assumption of imperfections in the capital markets.

[8]We are assuming that productivity is firm-specific but not worker-specific or, at any rate, that it is not possible to observe the exact productivity of a given worker and fire him if his productivity is below the wage.

and, in view of equation (1a),

$$y < w \cdot [1 - \gamma \cdot \mathbf{k} \cdot (1 - s) \cdot (1 + r) - h] \,. \tag{2a}$$

Whenever productivity is below this threshold a firm goes bankrupt and all its workers lose their job. Therefore the probability λ of losing a job is nothing but:

$$\lambda = \Psi \left(w \cdot [1 - \gamma \cdot \mathbf{k} \cdot (1 - s) \cdot (1 + r) - h] \right) . \tag{3}$$

Since s is assumed equal for all firms, we have that the probability of being fired is the same for all workers, whichever the firm they are employed in.

For the sake of notation, we denote as

$$\tilde{\lambda} = \Psi \left(w \cdot \left[1 - \gamma \cdot \mathbf{k} \cdot \left(1 - s - \frac{1}{N} \right) \cdot (1 + r) - h \right] \right) \tag{3a}$$

the probability of failure of a firm in which one more worker has switched from T to the F scheme. Accordingly the quantity $\phi = \tilde{\lambda} - \lambda$ is the increase in the probability of failure of a firm induced by one more worker switching to the F scheme, i.e. it is the *extra damage* produced by last switch to F. In the Appendix B we shall prove

Proposition 1 *Provided* $\mathbf{k} > 0$ *we have*

1. $\frac{\partial \lambda}{\partial s} \geq 0$*: the probability of bankruptcy of a firm increases with the share of workers enrolled in the F scheme.*

2. $\frac{\partial \phi}{\partial N} < 0$*: the extra-damage of one more switch to the F scheme is lower the greater the size of the firm.*

3. $\lim_{N \to \infty} \phi = 0$*: the extra-damage of one more switch to the F scheme is null in firms of very large size.*

4. *Provided the density of the shocks is not increasing to the left of the mean*

   $\frac{\partial \phi}{\partial s} \leq 0$*: the extra-damage of one more switch to the F scheme is lower the higher the share of those already enrolled into F.*

Point 1 in Proposition (1) is worth stressing, since it is crucial in what follows: an increase in the number of workers switched to the F scheme increases the probability of failure of their own firm and hence their own probability of loosing the job. This is due to the fact the disappearance of the T contributions as a consequence of the adhesion to the F scheme weakens the financial structure of the firm and hence its capacity to resist to negative external shocks; therefore the adhesion to a F scheme has private advantages (higher returns) for the adherents but generates an damage to the firm and, as a resort, a negative externalities to all the workers, either passed to F or not, who find themselves in face of a higher risk of being fired.

2.3 Workers' characteristics and utilities

Workers have identical preferences, infinite lives and discount the future at an identical rate β. In our model workers have to decide in which scheme (T or F) to invest the mandatory pension contribution $\gamma \cdot w$. Since we assume that the adhesion to F is irreversible, we allow the possibility of switching only for those workers that are currently enrolled in the T scheme (which can be considered the "default" status).

To examine the respective benefits of the two options we consider them separately and let δ be the probability of an unemployed worker to be hired.

Permanence at the T In this case an employed worker receives the amount $(1 - \gamma) \cdot w$ for immediate consumption and the amount $\gamma \cdot w$ is kept within the firm and given back to him at the end of career, revaluated at a yearly risk-free rate r. We assume that instant utility is a positive function of immediate consumption and of the end of career payments and we denote it by $u(w, r)$. Next, following a standard job search setup[9], we define $V_E(T)$ as the present expected value of the lifetime utility of currently being employed and enrolled in the T scheme; then the flow utility is given by:

$$\beta \cdot V_E(T) = u(w, r) + \lambda \cdot [V_U(T) - V_E(T)] \tag{4}$$

where $V_U(T)$ is the present expected value of lifetime utility when unemployed. Substantially this flow value of being employed is given by the flow utility from consumption and the expected change in the asset expected value (from employment to unemployment with probability λ).

In a similar way we can write the asset flow for an unemployed worker enrolled into the T scheme as

$$\beta \cdot V_U(T) = u(b, r) + \delta \cdot [V_E(T) - V_U(T)] \tag{4a}$$

where $u\left(b, r\right)$ is the instant utility from consumption in the unemployment state (when worker receives the subsidy share b of wage). Combining (4) and ($4a$) and rearranging we have

$$V_E(T) = \frac{(\beta + \delta) \cdot u(w, r) + \lambda \cdot u(b, r)}{\beta \cdot (\beta + \lambda + \delta)}. \tag{5}$$

The switch to F The switch to F has two main consequences: first, the contributions are revalued in each period t at the stochastic rate ρ_t drawn from a normal distribution with a positive mean $\bar{\rho}$ ($\bar{\rho} > r$); second the share of workers opting for F increases by $1/N$, so that the probability for the firm to go bankrupt rises and becomes $\tilde{\lambda}$. If we call $Eu(w, \rho)$ the instant expected utility of an employed ($Eu(b, \rho)$ when unemployed) agent enrolled

[9]See Cahuc and Zylberg (2004), pages 109-113.

in the F scheme we can obtain $\beta \cdot V_E(\underrightarrow{TF})$, the flow expected utility of being employed for a worker who switched to the F scheme:

$$\beta \cdot V_E(\underrightarrow{TF}) = Eu(w,\rho) + \tilde{\lambda} \cdot \left(V_U(\underrightarrow{TF}) - V_E(\underrightarrow{TF})\right) \tag{6}$$

where $V_U(\underrightarrow{TF})$, is the expected utility of being unemployed, whose flow is given by:

$$\beta \cdot V_U(\underrightarrow{TF}) = Eu(b,\rho) + \delta \cdot \left(V_E(\underrightarrow{TF}) - V_U(\underrightarrow{TF})\right). \tag{6a}$$

The resulting expected value of being employed for a worker switching to F is:

$$V_E(\underrightarrow{TF}) = \frac{(\beta+\delta) \cdot Eu(w,\rho) + \tilde{\lambda} \cdot Eu(b,\rho)}{\beta \cdot \left(\beta + \tilde{\lambda} + \delta\right)}. \tag{7}$$

2.4 Individual incentives and endogenous choice

Consider a worker who is currently in the T scheme: his expected utility is given by (5) and he knows that, if he opts for the F scheme he will obtain (7). Then, a worker will switch from T to F if and only if $V_E(\underrightarrow{TF}) > V_E(T)$, that is:

$$\frac{(\beta+\delta) \cdot Eu(w,\rho) + \tilde{\lambda} \cdot Eu(b,\rho)}{\beta \cdot \left(\beta + \tilde{\lambda} + \delta\right)} > \frac{(\beta+\delta) \cdot u(w,r) + \lambda \cdot u(b,r)}{\beta \cdot (\beta + \lambda + \delta)} \tag{8}$$

and, given the irreversibility of the choice, an equilibrium will be reached when $V_E(\underrightarrow{TF}) \leq V_E(T)$: in such case no further workers will switch to F and hence the share of adhesion s will be stable. We can rearrange the above and obtain the incentive $I \equiv V_E(\underrightarrow{TF}) - V_E(T)$:

$$I = \frac{1}{\beta \cdot (q+\lambda)} \left(q \cdot G - q \cdot \frac{1}{\frac{q+\lambda}{\phi} + 1} \cdot P + \lambda \cdot B \right). \tag{9}$$

where $q = \beta + \delta$, $G = Eu(w,\rho) - u(w,r)$, $P = Eu(w,\rho) - Eu(b,\rho)$ and $B = Eu(b,\rho) - u(b,r)$.

The incentive is made up of three parts: the first one represents the financial gain of switching to F and is related to G; the second part is the cost of switching and depends, among other things, on the loss during unemployment P and on the 'extra damage' ϕ; the third part is given by B, i.e. the difference in utilities that the two schemes grant when unemployed.

The incentive function (9) is not easily tractable since it depends on the sign and the magnitude of the terms G, P and B and no general properties can easily be found, apart the rather obvious fact that $\dfrac{\partial I}{\partial G} = \dfrac{q}{\beta \cdot (q+\lambda)} > 0$, i.e. the incentives to switch to the F scheme become greater the greater the direct gains in utility from the adhesion to F are.

However in a particular, though plausible, case the following Proposition can be stated, whose proof is relegated to the Appendix B:

Proposition 2 *Suppose that $G = Eu(w,\rho) - u(w,r) > 0$ and $B = Eu(b,\rho) - u(b,r) > 0$; then the following properties hold:*

1. $\frac{\partial I}{\partial N} > 0$*, i.e. the incentive increase as the size of firm grows.*
2. $\lim_{N \to \infty} I > 0$*, i.e. in sufficiently large firms, the incentive is always positive.*

Moreover if $B \geq G$ and the density of the shocks is not increasing to the left of the mean, then

3. $\forall N \quad \frac{\partial I}{\partial s} \geq 0$*, i.e. the incentive increases with the share of workers already switched to F.*

The assumption that G and B are positive implies that the degree of risk adversion is not high enough to offset the higher mean rate of return of pension funds. The condition $B \geq G$ can be shown to be stisfied under the assumption of low prudence.

As a Corollary to what remarked in Proposition 2.3, we have that the value s^* that nullifies incentives is unambiguously determined and is unique whenever $B \geq G$ and the density of the shocks is not increasing to the left of the mean since, under these conditions, the incentive is a monotonically increasing function of s. However, apart from this situation, the form of the incentive function depends crucially on the exact functional form of the instant utility and of the cumulative density function of the productivity shocks, so that, in general, there could exist more values of s abating the incentive to switch to the F scheme.[10]

Finally, it is worth noticing that both h and $\mathbf{k}$ affect negatively the probability of failure λ. However, their effect on the latter is ambiguous in that, as we can see from equation (9), a change in λ affects in the same direction both the 'financial gain' and the 'cost of switching', so that the final effect on I depends on the exact specification of λ and $u(.)$. Again, in some specific cases, it is possible to state the following Proposition which is proved in the Appendix B:

[10]Through this section we have somehow given for granted a relevant point, that is, when analyzing the possible alternatives that a worker faces, we did not consider the possibility that he simply postpones the switching to a future period. Indeed this third possibility can be ruled out because it is always suboptimal as we prove in Appendix B.

Proposition 3 *Suppose that $B \geq G$ and the density of the shocks is not increasing to the left of the mean, then the following properties hold:*

1. $\frac{\partial I}{\partial \mathbf{k}} \geq 0$, *i.e. the incentives decrease as the number of yearly payments held within the firm grows.*

2. $\frac{\partial I}{\partial h} \geq 0$, *i.e. the incentives decrease as the share of own capital over wage increases.*

2.5 A simple case: uniformly distributed shocks

We study now the case where productivity shocks are uniformly distributed: for the sake of brevity we confine our discussion to the case in which G and B are both positive and $B \geq G$, which we believe to be the most interesting case.

Suppose that $\frac{Y}{N}$ is drawn from a continuous uniform distribution that ranges from 0 to twice the average costs AC (so that profits are, on average, equal to zero), then $\Psi(x) = \frac{x}{2 \cdot AC}$. In these circumstances equation (9) and the properties described by Proposition 1, 2, 3 still hold and in addition we have that:

$$\begin{gathered}\lambda = \frac{1 - \gamma \cdot \mathbf{k} \cdot (1 - s) \cdot (1 + r) - h}{2 \cdot (1 + h \cdot \iota)} \\ \text{for } 0 < 1 - \gamma \cdot \mathbf{k} \cdot (1 - s) \cdot (1 + r) - h < 2 \cdot (1 + h \cdot \iota)\end{gathered} \tag{10}$$

and that

$$\phi = \frac{\gamma \cdot \mathbf{k} \cdot (1 + r)}{2 \cdot (1 + h \cdot \iota)} \cdot \frac{1}{N} \tag{10a}$$

where w was, without loss of generality, normalized to 1. The above equations tell us that s only influences λ and not ϕ. Note that when the condition $0 < 1 - \gamma \cdot \mathbf{k} \cdot (1 - s) \cdot (1 + r) \cdot w - h \cdot w < 2 \cdot w \cdot (1 + h \cdot \iota)$ is not met, λ is either one or zero: these latter cases are trivial and thus we omit their analysis.

We can examine how the incentive depends on the share of adhesion simply deriving equation (9) with respect to s:

$$\frac{\partial I}{\partial s} = \frac{1}{\beta \cdot (q + \lambda)} \left[q \cdot \phi \cdot \frac{P}{(q + \lambda + \phi)^2} + B - \beta \cdot I \right] \cdot \frac{\partial \lambda}{\partial s}. \tag{11}$$

A few results follow from the above: first, for negative values of the incentive the derivative is always positive; second, when the incentive is positive the sign is undetermined and is defined by the sign of $q \cdot \phi \cdot \frac{P}{(\beta + \lambda + \phi \cdot)^2} + B - \beta \cdot I$; finally when N is large enough ϕ tends to zero and $B - \beta \cdot I < 0$ and the derivative is necessarily negative.

In figure 1 we represent two possible shapes of the incentive function: in one the curve is always positive, in the other it crosses the horizontal line between 0 and 1.

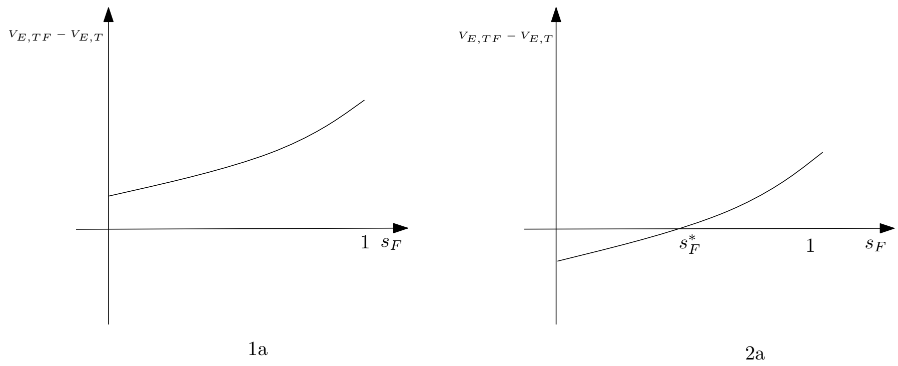

Figure 1: Shapes of the incentive function

Note that the results stated above imply that 1) the incentive curve cannot intersect the horizontal axis from above (in that $\dfrac{\partial I}{\partial s} > 0$ when $I < 0$ and the I curve is continuous in the (0,1) interval) and that 2) the intersection, s^* if it does exist, is unique. However, s^* cannot be a stable equilibrium and is, rather, a threshold: when below that value no further adhesions occur and s stays constant at its current level, when above that value all workers find it convenient to switch and s eventually reaches one.

Summing up, under the hypothesis of uniformly distributed shocks and without agents' heterogeneity it is possible to identify a threshold value of s which constitutes an unstable equilibrium. Above that value, and in the absence of frictions, all workers switch to F, while below that value no further worker does. It follows that the outcome in terms of participation rates is binary, either the initial level of s or 1. In addition, the variation of the conditions of the system affects the value of the threshold, determining the likelihood of ending in one of the two possible outcomes; for example, a higher size of firms decreases the values of the threshold and, hence, increases the probability that all workers switch to the F.

3 The simulation strategy

The model examined in the previous Sections sheds some light on the behaviour of agents and the characteristics of the incentives they face when contemplating the switch to the new F scheme (see Proposition 2). However it is not completely satisfactory at least in three respects:

1. the incentive function crucially depends on the individual valuation of the different states in which an agent can find himself after a choice, i.e. incentives may differ depending on the specific form of the preferences of the worker and his degree of risk aversion, i.e. the explicit

consideration of *heterogeneity in workers' characteristics* is called for.

2. the incentive function depends also on the specification of the failure probability of the firms, and this latter, apart from the particular form of the probability of the shocks to productivity, is heavily affected by

   (a) the size of the firm itself (N);

   (b) the financial structure of the firm ($\mathbf{k}$ and h)

   whereas the theoretical analysis of Section 2 deals only with the simplified case in which all firms are of the same size and have an identical financial structure. In other words, the consideration of *heterogeneity in firms' characteristics* is called for.

3. workers' incentives of course depend on the other workers' decisions through s, but, as shown in Proposition 2, a same value of s gives different incentives in firms of different sizes and the system may be in a resting point with different adhesion rates in firms of different sizes. This fact may affect individual decisions through the expectations that an agent, fired by a firm, has about the possibility to be hired in a firm of different size. The theoretical part did not take into account this effect since the analysis concentrated on firms of identical sizes, but a more realistic framework should tackle this point; in other words, a more explicit consideration of the *interaction* among workers' decisions and expectations is called for.

To deal with these aspects we set up a simulation framework to gain some insights into the working of an economy stylized as in Section 2 with the superimposition of explicit elements of heterogeneity and interaction that would make a formal analysis intractable. To this purpose, we adopt a standard Agent Based Model approach modelling agents as follows.

3.1 Workers

We have a population $\Im$ of workers, each of them described by the following vector of characteristics:

$$W_i = \{a_i, \beta_i, j_i, \alpha_i, H_i\} \quad \forall i \in \Im \tag{12}$$

where

a_i is a parameter defining individual preferences;

β_i is the individual discount rate;

j_i identifies the firm which i works in;

α_i is a parameter indicating the probability that an agent will actually switch to F when he has positive incentive[11];

H_i describes the information available to i and is made up by the knowledge of the financial structure of the firm j_i and the distribution of the failure rates of firms across the economy.

3.1.1 Consumption levels and instant utilities

We assume worker's preferences are represented by the following instant CRRA utility function:

$$u_i(c) = \frac{c^{a_i}}{a_i} \tag{13}$$

where c is instant consumption and a is the risk aversion coefficient ($a < 1$ represents risk aversion, while $a > 1$ represents a risk prone attitude).

As described in Section 2, agents receive an income w when employed and $b \cdot w$ when unemployed and in either state an amount $\gamma \cdot w$ is forcedly invested in a pension plan (either T or F); these latter payments cumulates at a given rate and will be given back to him only at the end of the working career. Since agents have infinite lives, we assume that they smooth this wealth over the working life and approximate this pension with an annuity p_τ, $\tau \in \{T, F\}$, whose future value at a risk free rate (assumed equal to ι) is equal to the future value of periodical payments $\gamma \cdot w$. Clearly p_τ depends on the rate of return of the investment scheme[12] and will be a single value in the case of T (where accumulation occurs at the certain rate r) while it will be a random variable in the case of F (when accumulation occurs at the stochastic rate ρ).

By this token, we have the following utility levels

T case, employment state: $u_i(w, r) = u_i((1 - \gamma) \cdot w + p_T)$

T case, unemployment state: $u_i(b, r) = u_i((b - \gamma) \cdot \cdot w + p_T)$

F case, employment state: $Eu_i(w, \rho) = \int_{-\infty}^{+\infty} u_i((1-\gamma) \cdot w + p_F) \cdot f(p_F)\, d\, p_F$ where $f(p_F)$ is the distribution function of the random variable p_F[13]

F case, unemployment state: $Eu_i(b, \rho) = \int_{-\infty}^{+\infty} u_i((b - \gamma) \cdot w + p_F) \cdot f(p_F)\, d\, p_F$.

[11] This parameter is not necessarily, and indeed will not be, 1; by this we mean that there are some frictions in the process of switching and we can imagine that these are due to misinformation, lack of financial literacy or a sort of aversion to changing: all these aspects are measured by the parameter α. We imagine that the information is shared among workers belonging to the same firms so that α will be the same for all workers of a given firm.

[12] It depends also on other factors such as the fiscal regime, fiscal rebates, possible additional contributions from firms and the age of retiring.

[13] Indeed this distribution function will be computed numerically as shown in the Appendix C.

3.1.2 Expectations

We assume that every worker formulates expectations about the future probabilities of being employed in his own original firm (ϵ), or being unemployed (η) or being employed in another firm (θ). The expectation formation mechanism follows a simple adaptive scheme represented by a dynamic system

$$\epsilon_i(t+1) = \epsilon_i(t) \cdot (1 - \lambda_{j_i}) \tag{14}$$

$$\eta_i(t+1) = \eta_i(t) \cdot (1 - \delta) + \lambda_{j_i} \cdot \epsilon_t + \Lambda_i \cdot \theta_i(t) \tag{14a}$$

$$\theta_i(t+1) = \theta_i(t) \cdot (1 - \Lambda_i) + \delta \cdot \eta_i(t) \tag{14b}$$

where λ is the probability of bankruptcy of the firm which i is working in, δ is the reabsorbing rate and Λ is the average probability of bankruptcy of all other firms except j_i, that is the one which agent i works in.

Imposing the obvious initial conditions $\epsilon_i(0) = 1, \eta_i(0) = 0$ and $\theta_i(0) = 0$, the above dynamical system has a solution

$$\epsilon_i(t) = (1 - \lambda_{j_i})^t \quad \forall t \geq 0 \tag{15}$$

$$\eta_i(t) = \begin{cases} 0 & \text{for} \quad t = 0 \\ \lambda_{j_i} & \text{for} \quad t = 1 \\ \frac{\left((1-\lambda_{j_i})^t - 1\right)\cdot(\lambda_{j_i} - \Lambda_i)\cdot\Lambda_i + \delta\cdot\left((1-\lambda_{j_i})^t\cdot(\lambda_{j_i}-\Lambda_i) - \lambda_{j_i}\cdot(1-\delta-\Lambda_i)^t + \Lambda_i\right)}{(\delta+\Lambda_i)\cdot(\delta-\lambda_{j_i}+\Lambda_i)} & \text{for} \quad t \geq 2 \end{cases} \tag{15a}$$

$$\theta_i(t) = \begin{cases} 0 & \text{for} \quad t < 2 \\ -\frac{\delta\cdot\left(-\delta+\lambda_{j_i}-\lambda_{j_i}\cdot(1-\delta-\Lambda_i)^t - \Lambda_i + (1-\lambda_{j_i})^t\cdot(\delta+\Lambda_i)\right)}{(\delta+\Lambda_i)\cdot(\delta-\lambda_{j_i}+\Lambda_i)} & \text{for} \quad t \geq 2 \end{cases} \tag{15b}$$

Clearly the expected probabilities of being employed or unemployed as a result of a switch to the F scheme are the same as above simply replacing the probability of default λ_{j_i} with $\tilde{\lambda}_{j_i}$ and of default of other firms Λ_i with $\tilde{\Lambda}_i$, where the latter may differ from Λ_i because anyone knows that, switching to F, he may contribute to the deterioration, with respect to the presently observed situation, of the financial conditions of any firm in which he can happen to enter.

3.1.3 Lifetime utilities

In any period an agent expects to be employed or unemployed with the probabilities given above and hence, with same probabilities, he will receive the corresponding payoff.

The T case In this case the instant expected utility of an agent $i \in \Im$ in a generic period t is

$$Eu_{i,t}(T) = (\epsilon_i(t) + \theta_i(t)) \cdot u_i(w, r) + \eta_i(t) \cdot u_i(b, r) \tag{16}$$

Summing up over t and discounting at the rate β_i gets the lifetime utility of remaining at the T scheme, i.e.

$$V_{E,i}(T) = \frac{u_i(b,r)\cdot\lambda_{j_i}\cdot(\beta_i+\Lambda_i)+u_i(w,r)\cdot\left(\beta_i^2+\delta\cdot\lambda_{j_i}+\beta_i\cdot(\delta+\Lambda_i)\right)}{\beta_i\cdot(\beta_i+\lambda_{j_i})\cdot(\beta_i+\delta+\Lambda_i)} \tag{17}$$

which simplifies to (5) when we assume $\Lambda_i = \lambda_{j_i} = \lambda \ \forall i \in \Im$.

Switching to F In this case the instant expected utility of an agent $i \in \Im$ in a generic period t is

$$Eu_{i,t}(F) = (\tilde{\epsilon}_i(t) + \tilde{\theta}_i(t))\cdot Eu_i(w,\rho) + \tilde{\eta}_i(t)\cdot Eu_i(b,\rho) \tag{18}$$

Summing up over t and discounting at the rate β_i gets the lifetime utility of remaining at the T scheme, i.e.

$$V_{E,i}(\underrightarrow{TF}) = \frac{u_i(b,r)\cdot\tilde{\lambda}_{j_i}\cdot(\beta_i+\tilde{\Lambda}_i)+u_i(w,r)\cdot\left(\beta_i^2+\delta\cdot\tilde{\lambda}_{j_i}+\beta_i\cdot(\delta+\tilde{\Lambda}_i)\right)}{\beta_i\cdot(\beta_i+\tilde{\lambda}_{j_i})\cdot(\beta_i+\delta+\tilde{\Lambda}_i)} \tag{19}$$

which simplifies to (8) when we assume $\tilde{\Lambda}_i = \tilde{\lambda}_{j_i} = \tilde{\lambda} \ \forall i \in \Im$.

3.2 Firms

We have a population J of firms of different sizes from 1 to N. They all have the same technology and each of them is described by the following vector of characteristics:

$$A_j = \{h_j, \mathbf{k}_j, \theta_j\} \quad \forall j \in J \tag{20}$$

where

$\mathbf{k}_j$ measures the per worker amount of contributions kept within the firm;

h_j measures the amount of social capital within the firm expressed as a percentage of the total wage bill;

θ_j is a dummy variable indicating whether the firm made an agreement with workers to share the burden of an extra contribution to the pension fund in the case they switch to F;

3.3 Economy-wide parameters and state variables

There are some parameters that describe the structure of the economy and some variables that are the result of individual actions and hence they may change through time due to the evolution of the system. All of them are common knowledge and, in particular, they can be briefly described as:

r the certain capitalization rate of the funds contributed by agents enrolled in the T scheme.

$f(\rho)$ the probability distribution of the uncertain capitalization rate ρ of the funds contributed by agents enrolled in the F scheme.

π the economy wide (assumed constant) inflation rate.

ι the certain return on private investments in capital. ι is also assumed to be the risk free rate of interest.

$(s_1, \ldots, s_J)$ the profile of the adhesion rates across firms. They in turn determine the profile of failure probability of each firm $(\lambda_1, \ldots, \lambda_J)$.

τ a set of parameters describing the fiscal treatments of wages, contributions and returns.

3.4 The mechanics of simulation

The simulation of the model works according to a simple mechanics. Initially each worker is generated drawing his specific parameters from a given distribution and is then assigned to a firm whose parameters have been randomly drawn as well. Then in any given period ($t = 0, 1, 2, \ldots$) we compute the value of the incentive function for every worker and according to that value we determine whether he switches to F or not. However a worker with positive incentive will actually switch only with the probability α_i.

Once the actual number of switching workers has been determined, a new period begins, in which a new s is determined in each firm according to what happened in the previous period. The new value of s determines a new default probability (possibly different from firm to firm) and these new probabilities, due to the expectations formation mechanism, affects the individual incentives for those workers that were still enrolled into the T scheme within the firm. Workers with positive incentives and selected for making the choice will switch to F thus changing the next period s within the firm, while the simultaneous choices of workers within the other firms will modify the adhesion rate elsewhere. This procedure goes on for several periods until the incentives of all workers are non-positive or the adhesion rate is 1: at that point an equilibrium is reached and the value of s becomes stable. In order for the simulations to be statistically significant, we perform the simulation with a large number of firms and workers[14].

[14] Indeed we perform sinulations with 4 millions firms and roughly 12 millions workers

4 The application to the italian case: an Assessment of the Italian TFR reform

4.1 The institutional framework in Italy after the recent reforms

The Italian TFR is regulated by the article 2120 of the Civil law Code (Codice civile) which states that each firm in the private sector has to put aside, for each tenured worker 6.91% of gross salary per year. These contributions are capitalized at 1.5% per year plus 75% of the inflation rate; therefore the TFR fund so far has represented a cheap source of financing for the firms. Employees have the possibility to partially withdraw from such a fund, although under very specific conditions (for example, to purchase a house or for medical expenditures). Upon his dismissal a worker has the right to obtain the whole TFR stock and both interests and capital are taxed at favourable rates[15].

In order to promote supplementary pensions in 2007 a reform was introduced for private sector employees, which entails the possibility of devolving the TFR to the CSS. The adhesion to PF is irreversible and it may occur through a mechanism of silent or implied consent. To make the switch from TFR to CSS more attractive to workers, a particularly favourable fiscal treatment for CSS has been conceived: in particular, the cumulated value of the investment obtained upon dismissal is taxed at a rate that ranges between 9-15% (depending on years of contributions) whereas in the case of TFR it is taxed at the average of last 5 years tax rate on personal income (usually around 23% but more for richer workers). Finally, the law explicitly allows for the possibility of receiving extra "employer contribution" for the workers switching to the CSS, provided that they add a voluntary contribution (currently these contributions amount to 1.16% and 1.27% of gross wage respectively) and that they opt for occupational PF. As far as firms are concerned, to partially offset the potential damage to the financial solidity of enterprises, the legislator has provided tax rebates for contributions transferred to CSS. The reform also discriminates between firms of different sizes; in fact workers employed in firms with more than 50 employees have to transfer their TFR to a publicly managed fund if they decide not to subscribe a PF. For this reason we focus our analysis only on firms with less than 50 employees.

The principle of "freedom of choice" explicitly stated by the law, has been safeguarded through the mechanism of silent or implied consent. However, while the choice of switching to PF is irreversible, the option of maintaining the contributions inside the firm can be reconsidered in any future period. Several authors argue that this asymmetry of treatment, together with other

[15]The entire stock of the TFR is insured by law, therefore, workers receive back their money even in the occurrence of the firms' bankrupcy and can consider it a safe asset.

critical aspects (such as the non-full portability of the "employer's contribution"), are mostly responsible for the partial failure of the reform.

As a matter of fact, the adhesion rates, after two years, are clearly unsatisfactory. As shown by Table 1(a), from 2006 to 2007 the rate of subscription to CSS has increased from 16.28% to 25.11% and remained nearly stable in 2008.

	Adherents to any kind of pension funds
2008	3603000
2007	3402135
2006	2161455
	Potential adherents to pension funds
2008	13870000
2007	13548800
2006	13278100
	Aggregate adhesion rates (%)
2008	25.98
2007	25.11
2006	16.28

(a) Adhesion to PF for private sector employees (source: COVIP 2006, 2007 and 2008)

	Adherents to pension funds that contribute with their TFR (excluding pre-1993 adherents)
2008	2403042
2007	2274285
2006	1163501
	Potential adherents to pension funds (excluding pre-1993 adherents)
2008	13386000
2007	13106800
2006	12861100
	Aggregate adhesion rates (%)
2008	17.95
2007	17.35
2006	9.05

(b) Adhesion to PF for private sector employees contributing with their TFR (our elaboration from COVIP data)

Table 1: Adhesion rates in italy

The situation is even worse if we consider that the above data refer to workers that have adhered to any kind of PF. If we focus only on workers that transferred their TFR to CSS and if we exclude those that had adhered to a PF before 1993, we obtain lower figures (see table 1(b)). The latter data are probably more suitable to describe the outcome of the 2007 reform which, as stated above, aimed at favouring the switch from TFR to CSS; hence we refer to these data in the rest of the paper. A second feature which is worth mentioning is that the adhesion rates are increasing with the size of the firm, as shown in the table below. In particular, table 2 shows how total adhesions are distributed among firms of different size and reveals that the distribution of adhesions and employment are significantly different. Consequently, adhesion rates vary greatly across size, with larger firms having higher adhesion rates.

	Distribution of employees (%)	**Distribution of adhesions (%)**			**Total adhesion rate (%)**		
Size of thefirm	**2006**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
1-19	40	10.70	14.10	12.50	2.43	6.15	5.64
20-49	14	9.00	10.40	9.00	5.90	12.81	11.46
50 - 249	18	22.80	25.40	25.10	11.05	23.62	23.38
250 +	28	57.50	50.10	53.40	18.76	31.36	33.42
Total	**100**	**100**	**100**	**100**	**9.05**	**17.35**	**17.95**

Table 2: Adhesion rates by firm size

In the rest of the paper we will try to shed light on these features of the outcomes of the 2007 reform.

4.2 The setting of base parameters

In this section we simulate the above framework to assess the outcomes of our model tailored to the Italian experience. In order to pursue this goal, first we have to fix proper values for the basic parameters of the model and, since it was not always possible to obtain exact measurements of them, we adopted the following empirical strategy:

1. we use existing data when available;
2. we resort to proxies for all other variables;
3. we set the standard deviations of the parameters, when their value is not available, to one third of their mean.

The idea behind the last point is to allow the parameters to show some variance without producing economically unreasonble values[16].

To perform the simulation we also have to specify some further details, such as the tax regime and fiscal rebates, firms' contribution and so on. From these points of view the simulation replicates both the pre and post reform scenarios in Italy. After replicating the pre and post reform periods, we push the analysis forward and try to make some predictions on the future adhesions to the Italian CSS.

Workers As far as workers are concerned, they are basically defined by the degree of risk aversion and by the rate at which they discount the future; we assume these parameters are drawn from normal distributions with means and standard errors described in the table below.

Workers' parameters		
	Mean	Standard Deviation
Discount rate	0.02	0.0066
Risk aversion coefficient	-2	1.5
Share of risk averse workers	95%	

Table 3: Workers' parameters

We set the average risk aversion coefficient equal to -2 because there is a wide consensus in the literature that this can be a realistic value, for instance Schlechter (2007); its variance was chosen to deliver a reasonable share of risk averse population.

Firms The financial structure of the firms is basically determined by two parameters: the amount of TFR payments that are kept within the firms ($\mathbf{k}$) and the ratio of own capital over total wage bill (h), both measuring how

[16] In particular, most parameters are economically significant only for positive values: setting the standard deviation to one third, we confine the possibility of an unrealistic value to the extreme tail of the distribution.

much the firms can rely on these sources of credit before going bankrupt. Data from **k** were taken from Ministry of Labour and Social Policies (2002) and data for h were derived from Bardazzi and Pazienza (2005).

Each firm is also defined by the presence or absence of an agreement with an occupational PF: the probability of this occurrence was proxied by the ratio of potential adherents to occupational Pension Funds over total private sector employees, so that it measures the probability that a worker can effectively subscribe to an occupational pension fund which grant the extra contribution from the employer. Finally the value of the parameter representing the degree of information α (that we assume to be firm specific), in the absence of exact data, was chosen according to some proxies taken from two different surveys. More precisely, we set $1 - \alpha = 0.5$ (i.e. $\alpha = 0.5$) in the pre-reform period, that is the percentage of workers interviewed in 2002 by Bank of Italy who declared either to be unable to predict their future pension or not to be in the need of a supplementary pension. As for the post reform, we could rely on a more precise proxy and we set $\alpha = 0.7$ because the ISAE (2005) survey showed that, at the end of 2005, 71% of workers were informed about the TFR reform and the possibility to switch to F. The values of the parameters for the firms are summarized in the table below.

Firms' parameters		
	Mean	Standard Deviation
Amount of TFR payments kept within the firm	5.17	1.72
Capital share over total wage bill	0.339	0.113
Degree of information (pre-reform)	0.5	0.16
Degree of information (post-reform)	0.7	0.23
Agreement probability (pre-reform)	0.69	
Agreement probability (post-reform)	0.78	
Ratio of Standard error to average productivity	033	

Table 4: Firms' parameters

System parameters System parameters describe the economic system and therefore are common across all firms and workers. These parameters determine aspects of the labour market (the hiring rate and the replacement rate), of the credit markets (interest rates on loans to firms and interest rates on consumer credit), and of the working of the F scheme (the contribution share over gross wage, the tax rate on contributions and on interests, the real returns in the F and T schemes). The data for the unemployment benefits are obtained as the average of the replacement wage that was fixed by the law during the period we are examining. The values of expected return in the F scheme are another key issue. For the simulation of the pre-reform phase we used historical data and we adopted the average rate of return of PF over the years 1999-2006, as given in Cesari et al. (2007). Things are more complex for the post-reform period: first, long enough time series are not available and second, the 2008 financial crisis is likely to have induced lower expectations on returns for F investments. Hence we decided to vary the pre-reform expectations using as a proxy the reduction of the returns on long terms government bonds (10 years BTP in our case) in the second part of 2008, according to the data provided by Bank of Italy.

Moreover, the reforms introduced some benefits for those workers opting for the F scheme, in the form of better fiscal conditions: in the simulation we use those benefits to compute the annuities p_T and p_F as described in Appendix C. Finally, in our model average productivity is simply a numeraire on which wages are based. Therefore values of productivity and wages are simply chosen to be in scale with the rest of the variables. All values used in the benchmark simulation are summarized in Table 5.

System parameters		
	Mean	Standard Deviation
Contribution to TFR and PF as a share of wage	0.0691	-
Firm's contribution to PF	0.0116	-
Worker's voluntary contribution to PF	0.0127	-
Hiring rate	0.9	-
Risk free interest rate	0.05	-
Rate of return on invested capital	0.05	-
Pre-reform parameters		
Nominal rate of return over PF contributions	0.045	0.02
Inflation rate (average 1996-2006)	0.0225	-
Tax rate on TFR contributions	0.23	-
Tax rate on PF contributions	0.23	-
Replacement rate from unemployment benefit	0.357	-
Post-reform parameters		
Nominal rate of return over PF contributions	0.0427	0.02
Inflation rate (average 1998-2008)	0.0242	-
Tax rate on TFR contributions	0.23	-
Tax rate on PF contributions	0.09	-
Replacement rate from unemployment benefit	0.55	-

Table 5: System parameters

4.3 Simulation results

We present now the results of the simulations, starting from the benchmark case performed according to the strategy presented above. Two features of the results are worth mentioning. First, as it is clear from Figure 2, the simulated participation rates neither stay at their starting level (0 at the beginning of the pre-reform period) nor reach 1, but lie somewhere in between. Second, the equilibrium value of s is significantly dependent on the size of the firms, with bigger firms displaying higher values of the adhesion rates.

Table 6 summarizes the results of the simulation and shows that they are quite in line with the observed values of the adhesion rates, both for pre and post reform periods.

Next, we present the results of the sensitivity analysis on the main parameters of the model. The reason for such analysis is twofold: on the one hand, we want to check whether the results are robust to changes of the parameters (i.e. small changes of the latter do not produce unrealistic out-

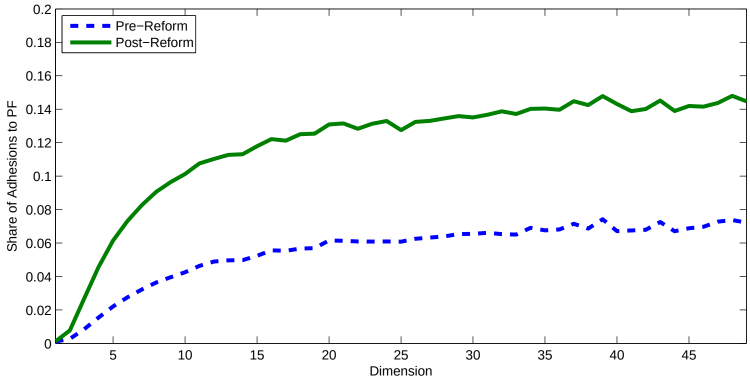

Figure 2: Adhesion rates before and after the reform

Adhesion rates for class size (%)				
Class size	**Real value 2006**	**Simulated value 2006**	**Real value 2008**	**Simulated value 2008**
1-19	2.43	2.19	5.64	5.35
20-49	5.90	6.49	11.47	13.52
1-49	3.32	3.16	7.16	7.16

Table 6: Simulation results: adhesion rates

comes) and whether the simulated effects of such changes on the equilibrium values of s display the expected signs. On the other hand we aim at sheding some light on how adhesion rates react to different scenarios concerning the economic environment or the incentives to adhere to PF.

To accomplish the first goal we compute the adhesion rates of the post-reform period (years 2007-2008), for different values of the main parameters of the model. The results, presented in Figure 3, show that almost all parameters have the expected effect on the adhesion rates and that the results are rather stable. In particular, although with few exceptions, when the parameters are allowed to take the highest values explored in our simulations, the adhesion rates almost double (or are halved in the case of variation of the standard deviation of the productivity shock), while in the case of changes of the share of firms' own capital the participation to the PF scheme are even higher. However, if we focus on the interval $\pm 30\%$ around the benchmark values of the parameters under investigation, we can see that results are particularly sensitive to unemployment benefits, to the returns to PF and to the volatility of the productivity shocks.

On the contrary, neither the hiring probability nor the volatility of the PF return rates appear to play a significant role. As for the former, this outcome may depend on the fact that the increase of the hiring probability makes the individual better off in either states, i.e. T or F, moreover we can add that according to our model, the gain from the higher reabsorbtion

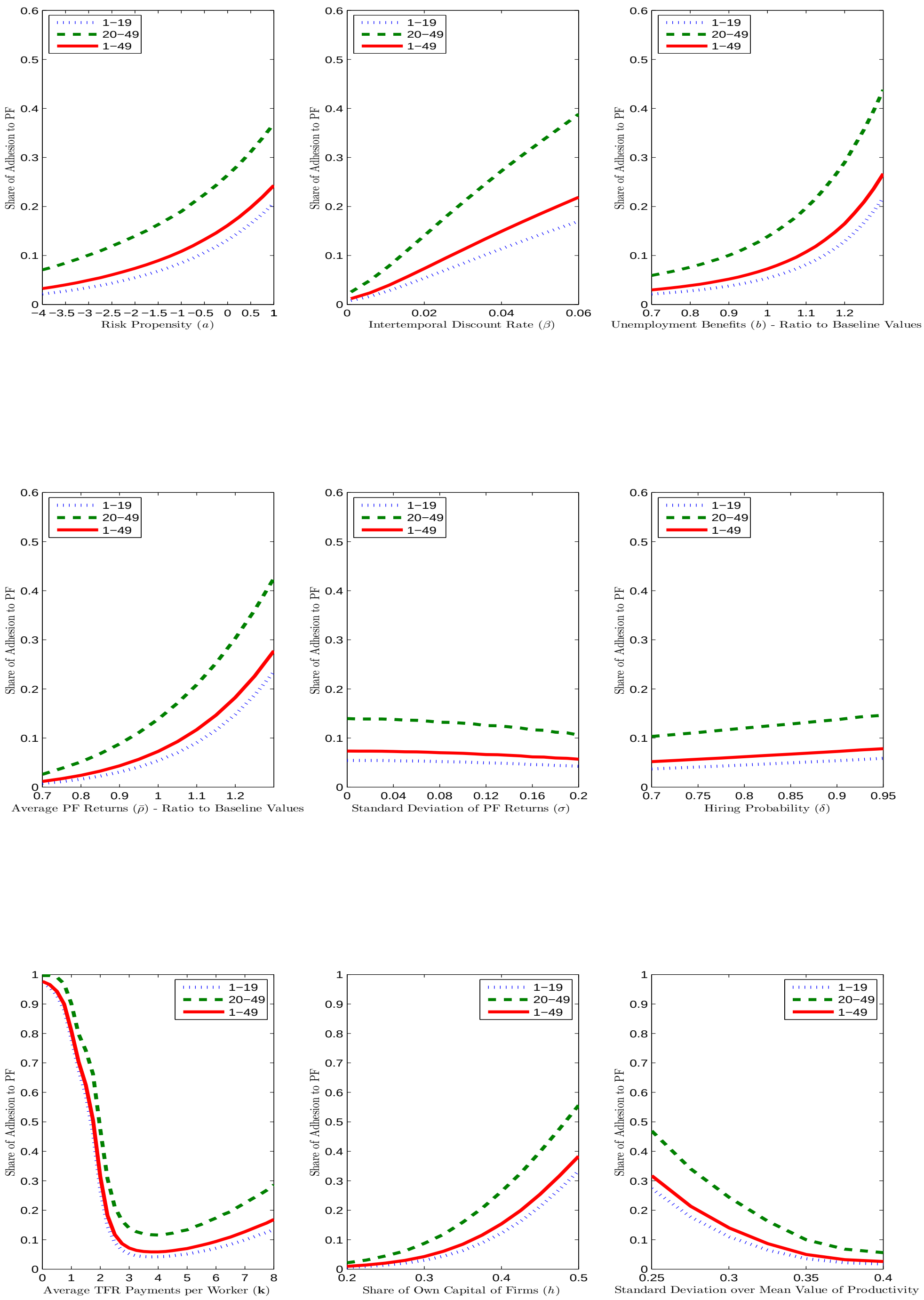

Figure 3: Sensitivity analysis for some key parameters

probabilty is slightly more likely to occur in the F case, where the chance of being unemployed is higher.

As for the volatility of PF return rate, the reason for the relatively low sensitivity of the results stems from the fact that the contribution of the "lottery" (i.e. the F returns) to the overall utility is rather small (according to our parameters, the pension annuities amount to 5-7% of the gross wage), such that higher losses or gains from the lottery do not affect significantly the individual welfare. As a consequence, the decision to adhere to the F scheme seems to be driven mostly by the expected value of the gain rather than its volatility, on the one hand, and on the loss of welfare in case of unemployment on the other hand.

As for the volatility of PF return rate, the reason for the relatively low sensitivity of the results stems from the fact that the contribution of the "lottery" (i.e. the PF returns) to the overall utility is not particularly large (according to our parameters, the pension payments amount to 5-7% of the gross wage) and is generally outweighted by the huge loss in case of unemployemt.

Finally, the role of **k**, the average number of yearly contributions to the TFR scheme set aside by the firms, is worth to be commented. As shown by the Figure, its effect on the adhesion rates is not monotonic and, more precisely, is U shaped. The reason is that, when **k** increases, two opposite forces are at work. On the one hand, such an increase enhances the robustness of the firm, given that TFR contributions are an internal cheap source of cash flow; on the other hand, it amplifies the damage that worker's withdrawal of the TFR funds generates on the same financial solidity of the firm. According to our simulations it turns out that the latter effect tends to dominate the former for low levels of **k**, while it is offset for higher values of **k**.

We conclude this section by investigating the steady state (or long run) results of the reform; in particular, by exploring different scenarios concerning the economic performances of the PF scheme and the speed of the adhesion of workers (for example, due to enhanced information campaigns) we aim at assessing whether the current worrying scarce results of the 2007 reform are temporary or permanent. For doing this we perform some simulations by assuming values for the inflation rate and PF nominal returns (2.25% and 4.5% respectively, in line with the last decade values) and extend the simulation periods from 2 to 15 iterations, so that the reform has enough time to display its full effects: Figures 4 and 5 show the results of such an exercise.

As for the rate of return of the PF scheme, it can be seen that the adhesion rate are indeed significatively sensitive to this parameter but only when the latter is above 5% (that is only for extremely optimistic rate of return), we observe a relevant value of the adhesion rate. As for the role of the α parameter, that is the share of those workers that, having a positive

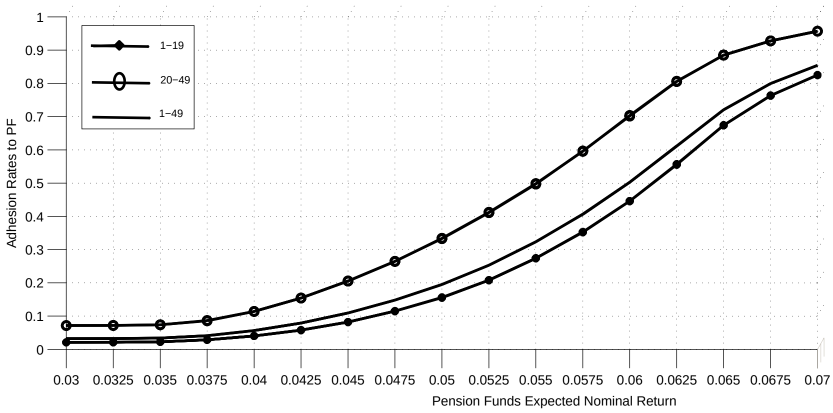

Figure 4: Long run outcomes for different expected returns of PF

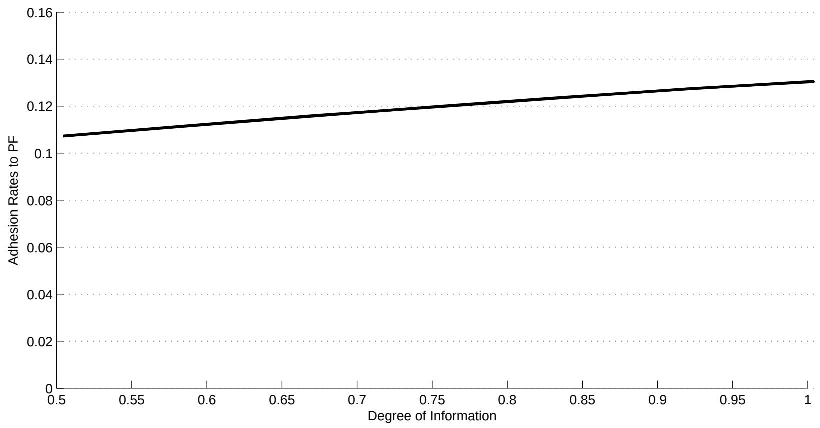

Figure 5: Long run outcomes for different degree of information

incentive to switch from TFR to PF, decide to do so, we observe a weak effect on the final adhesion rate. In particular, in the absence of frictions in the adhesion process (e.g. α equal to 1), the adhesion rates would be boosted up to 13%, which shows that results are rather insensitive to such a parameter.

values which appear too optimistic given the historical data for Italy. Similar results emerge in the presence of higher values of the α parameter, that is the share of those workers that, having a positive incentive to switch from TFR to PF, decide to do so. In particular, in the absence of frictions in the adhesion process (e.g. α equal to 1), the adhesion rates would be boosted up to 13%, which shows that results are rather insensitive to such a parameter.

Finally, as a mere numerical exercise, we present also the effects of a change in the fiscal treatment of both returns and accrued value of contributions to the PF scheme (recall that the current values of the tax rates are 11% and 9% respectively). According to our simulations (see Figure 6) it emerges that, in order to boost adhesions to the PF scheme, the most effective measure would be a reduction in the tax rate burdening the returns from PF: in fact, even increasing the tax on the accrued value (in order to offset at least partly the loss in total tax revenues), such a measure would deliver significantly higher rates of adhesion to the pension funds.

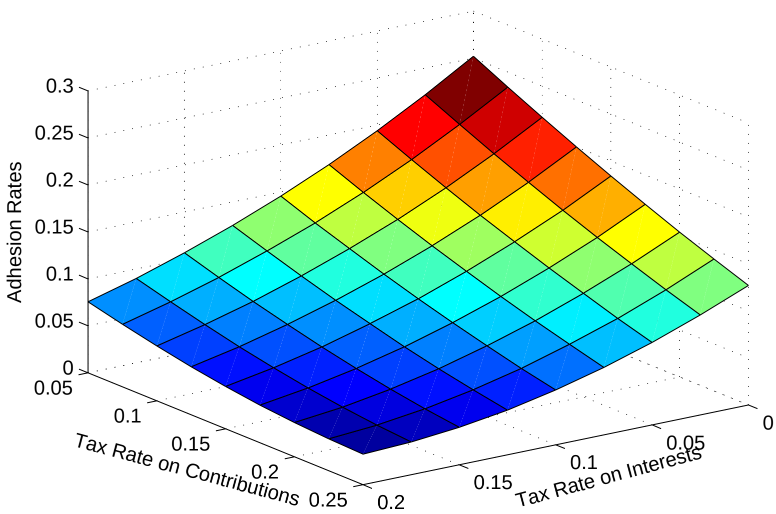

Figure 6: Adeshion rates for different levels of taxation

A possible reason for this outcome is that, although particularly favourable relative to the TFR scheme, the fiscal treatment of the PF accrued capital will display its full effects only upon retirement, which can be very far in the future in workers' life and thus can be hardly perceived as relevant in the choice of subscribing a pension plan, especially by young workers; on the contrary the reduction of the tax rate on the PF returns affects current flows of individuals' wealth accruals, thus making more attractive the adhesion to a pension fund. However, one has to keep in mind that such a policy (i.e. reduction of the interest rate tax and increase of the accrued capital tax) can be rather costly for the State, given that the increase of the latter tax rate would provide new resources only after several years, that is when individuals will start to retire or to withdraw from CSS (at least after 7 years, according to the reform). Indeed, such a cost could be partly offset by the increase in the adhesion rates to PF, given that the returns from PF and thus tax revenues, ceteris paribus, are higher than those from TFR. Anyway, the analysis of the exact cost for the State of such a policy change is beyond the scope of the present paper and is left for future research.

5 Conclusions

In this work we build a model representig the decision process of workers when choosing between different pension schemes and we use it to provide a possible explanation of the results of the Italian 2007 reform of complementary social security for private sector employees. In particular, in our model each worker when deciding whether to permanently adhere to CSS not only has to trade off the direct economic advantages and disadvantages (consisting in higher but riskier returns), but also has to take into account the effects of this individual decision on the financial health of the firm in which he/she is employed. In fact, the more workers switch to the PF scheme, the more they indirectly induce the risk of default of the firm in which they work in, since they erode a (cheap) source of internal financing in the presence of imperfect financial markets. However, the higher the number of workers employed in a firm, the lower will be the effect of the individual decision to switch to a pension fund on the financial health of the firm.

In view of this setting, the adoption of the PF scheme exposes workers to a twofold risk: the risk on the returns from the PF scheme and the (increased) risk of default of the firm in which they work in, which, in turn, would cause a reduction in private welfare, since workers are bound to spend some time in the unemployment state in the case of a default.

Clearly, the final decision on which scheme to adopt must trade off returns and risks and both the individuals' and aggregate outcomes will depend on three factors: (a) financial incentives provided by PF (b) firms' technological and financial conditions and (c) personal attitudes toward risk.

We worked out this framework both theoretically and through simulations. On the theoretical side we investigated the problem by means of a representative agent model assuming, for the sake of analytical tractability, identical individuals and firms. The main conclusions are that workers incentives to switch to PF depend positively on the expected returns of the PF, on the size of the firms and negatively to risk aversion. The financial structure of firm and the share of workers that already is also relevant in determining the incentive, with the latter suggesting the presence of a sort of net externality. However the exact sign of these effects is ambiguous apart some specific cases. Given the representative agent nature of the model, we also conclude that (unless there is some friction in the process of switching to PF) either all workers switch or no workers switch at all and the share of adhesions stays constant at the starting level.

Through simulations we examined the aggregate outcomes stemming from individual decisions, taking explicitly into account the heterogeneity of firms' and agents' characteristics and allowing also for more general assumptions on the distribution of productivity shocks. Under some simplifying assumptions on agents' expectations formation process we found that (i) given the strongly nonlinear structure of the decision problem and the interdependencies of the individual decisions with aggregate outcomes, the long run equilibria are not binary (either all workers stick to their current scheme or all adhere to PF), but we observe mixed situations in which part of the population switches to the PF while the other remain at the TFR scheme and (ii) there is a positive significant relation between the rate of subscription to the PF scheme and the size of the firm in which agents are employed, thus confirming the empirical evidence whereby we observe higher subscription rates in firms of larger size. The sensitivity analysis shows that adhesion rates are particularly sensitive to unemployment benefits, to returns from the PF and to productivity shocks. A more efficient distribution of the information about the PF scheme (financial literacy and information campaigns) seems to increase the speed of adoption but its effect on the long run rates of adhesion is scarce. Moreover, more optimistic scenarios on the returns from PF do not seem to overthrow the results, so that the expected adhesion rates in the regime phase of the reform will fail to reach high values. Finally, fiscal incentives have a relevant role on the adhesion rates, and in particular reductions of the tax rate on the interests are more effective than reductions in the tax rate on the final capital in increasing the long run adhesion rates.

Summing up, our results seem to grasp some basic features of the Italian experience, possibly shedding some light on the rationale and mechanisms behind it. In particular, the lack of efficacy of the reform may be due to: (a) the peculiarity of the Italian production system, populated by a large number of small and medium enterprises (SME), which have a fragile financial structure; (b) the institutional characteristics of the Italian labour market and the workers' preferences, opportunities and information sets.

A Data and Statistics

Tables is this section are taken from Covip (2008) and refers to the end of the years 2006 and 2007, unless otherwise specified.

Tab. A.1. *Gross Replacement rates between public pension and last wage for private sector employees and self-employed. Italian defined contribution scheme at the regime phase (%).*

	Before reforms	After reforms (regime phase)			
	35-40 years of contribution	Case 1: 35-40 years of contribution		Case 2: 35-40 years of contribution	
	Employees	Employees	Self-employed (or parasubordinati)	Employees	Self-employed (or parasubordinati)
60		58.46-66.82	35.43-40.49	54.18-61.47	32.83-37.25
62	70-80	62.23-71.11	37.71-43.09	57.76-65.53	35.00-39.71
65		69.85-79.83	42.33-48.38	64.86-73.59	39.30-44.6

Estimates obtained by using mortality tables of ISTAT 2004. Case 1: GDP rate of growth=1.5%, individual wages rate of growth=1.5%. Case 2: GDP rate of growth =1.3%, Individual wages rate of growth=1.6%. Contribution rates: 33% for employees and 20% for self-employed and "parasubordinati".

Tab. A.2. *PF in some OECD countries.*(1) (2) *Value of assets as a percentage of GDP.*

Paesi	2002	2003	2004	2005	2006
Australia	56.4	54.2	76.4	85.1	94.3
Austria	3.8	4.1	4.4	4.8	4.8
Belgium	4.9	3.9	4.0	4.5	4.3
Canada	48.5	47.3	48.1	50.3	53.4
Czech Republic	2.7	3.1	3.6	4.2	4.6
Denmark	26.0	28.5	30.9	33.6	32.4
Finland	49.2	53.9	61.8	68.7	71.3
France	..	1.3	1.2	1.2	1.1
Germany	3.5	3.6	3.8	4.0	4.2
Hungary	4.5	5.2	6.8	8.4	9.7
Iceland	84.3	98.5	106.9	120.1	132.7
Ireland	34.5	39.9	42.2	48.3	49.9
Italy	2.3	2.4	2.6	2.8	3.0
Japan	17.1	19.7	19.4	23.0	23.4
Korea	1.5	1.6	1.7	1.9	2.9
Mexico	5.2	5.8	6.3	9.9	11.5
Netherlands	85.5	101.2	108.4	122.5	130.0
New Zealand	13.0	11.3	11.3	11.3	12.4
Norway	5.5	6.5	6.6	6.7	6.8
Poland	3.8	5.3	6.8	8.7	11.1
Portugal	11.5	11.8	10.5	12.7	13.6
Slovak Republic	0.0	0.0	..	0.6	2.8
Spain	5.7	6.2	6.6	7.2	7.6
Sweden	7.6	7.7	7.6	9.3	9.5
Switzerland	96.7	103.6	108.2	119.1	122.1
Turkey	..	..	0.5	0.9	1.0
United Kingdom	59.2	64.8	68.1	79.1	77.1
United States	63.3	72.6	73.8	72.4	73.7

Source: OCSE. *Pension Markets in Focus.* several years.
(1) Data refers to autonomous PF whose gathered resources will generate only pension payments. *Cfr*. OECD, *Private Pensions: OECD Classification and Glossary*, 2005. (2) With respect to previous data from OECD there are some revision to the time series of a few countries, due to the change in the classification criteria of PF.

B Proof of Results of Section 2

Through all this section, to save on notation, we set $x = w \cdot [1 - \gamma \cdot \mathbf{k} \cdot (1-s) \cdot (1+r) - h]$ and $\tilde{x} = w \cdot [1 - \gamma \cdot \mathbf{k} \cdot (1 - s - 1/N) \cdot (1+r) - h]$. We then have $\lambda = \Psi(x)$ and $\tilde{\lambda} = \Psi(\tilde{x})$.

B.1 Proof of Propostion 1

We know that $\Psi(x)$ is a cumulative distribution function and thus, by definition, an increasing function of its argument (i.e. $\Psi'(x) \equiv \partial\Psi(x)/\partial x \geqslant 0$). Also $\phi = \tilde{\lambda} - \lambda = \Psi(\tilde{x}) - \Psi(x)$.

Point 1 We can easily compute

$$\frac{\partial x}{\partial s} = w \cdot \gamma \cdot \mathbf{k} \cdot (1+r) > 0 \tag{B1}$$

and since $\Psi'(x) \geqslant 0$

$$\frac{\partial \lambda}{\partial s} = \frac{\partial \Psi(x)}{\partial x} \cdot \frac{\partial x}{\partial s} \geqslant 0. \tag{B2}$$

Point 2 We can compute:

$$\frac{\partial \tilde{x}}{\partial N} = -w \cdot \gamma \cdot \mathbf{k} \cdot (1+r) \cdot \frac{1}{N^2} \leqslant 0 \tag{B3}$$

and

$$\frac{\partial x}{\partial N} = 0 \tag{B3a}$$

which, combined with $\Psi'(.) \geqslant 0$ necessarily imply $\partial\tilde{\lambda}/\partial N < 0$ and $\partial\lambda/\partial N = 0$. Then

$$\frac{\partial \phi}{\partial N} = \frac{\partial \tilde{\lambda}}{\partial N} - \frac{\partial \lambda}{\partial N} = \frac{\partial \tilde{\lambda}}{\partial N} < 0. \tag{B4}$$

Point 3 By definition $\phi = \Psi(\tilde{x}) - \Psi(x)$. Then:

$$\lim_{N\to\infty} \phi = \Psi\left(\lim_{N\to\infty} \tilde{x}\right) - \Psi\left(\lim_{N\to\infty} x\right) = 0. \tag{B5}$$

Point 4 If the density function of the shock is not increasing to the left of the mean we get $\Psi'(.) \geqslant 0$ and $\Psi''(.) \leqslant 0$. This said, since $\tilde{x} > x$ we have that an increase in s necessarily induces an increase in $\tilde{\lambda}$ that is not larger then the increase in λ; then

$$\frac{\partial \phi}{\partial s} = \frac{\partial \tilde{\lambda}}{\partial s} - \frac{\partial \lambda}{\partial s} \leq 0. \tag{B6}$$

B.2 Proof of Propostion 2

Point 1 By exploiting equation (9):

$$\frac{\partial I}{\partial N} = -\frac{q \cdot (\beta + \lambda)}{\beta \cdot (q+\lambda) \cdot (\beta + \lambda + \phi)^2} \cdot G \cdot \frac{\partial \phi}{\partial N} \tag{B7}$$

and in view of Propostion 1.2, it follows

$$\frac{\partial I}{\partial N} > 0. \tag{B8}$$

Point 2 From equation (9) we get:

$$\lim_{N\to\infty} I = \frac{G}{\beta \cdot (q+\lambda)} \cdot q + \lambda \cdot B > 0 \tag{B9}$$

since all involved quantities are positive either by construction or by assumption.

Point 3 Equation (9) can be rewritten as

$$I = \frac{B \cdot \lambda + q \cdot \left(G - \frac{P\cdot\phi}{q+\lambda+\phi}\right)}{\beta \cdot (q+\lambda)} \tag{B10}$$

and differentiating I with respect to s we get

$$\frac{\partial I}{\partial s} = \frac{q \cdot \left(B - G + \frac{P\cdot\phi\cdot(2\cdot(q+\lambda)+\phi)}{(q+\lambda+\phi)^2}\right) \cdot \frac{\partial\lambda}{\partial s} - \frac{P\cdot q\cdot(q+\lambda)^2}{(q+\lambda+\phi)^2} \cdot \frac{\partial\phi}{\partial s}}{\beta \cdot (q+\lambda)^2}. \tag{B11}$$

For $B \geq G$, since $\frac{\partial\lambda}{\partial s} > 0$ and $\frac{\partial\phi}{\partial s} \leq 0$ (as shown in Proposition 1.1 and 1.4), it follows that:

$$\frac{\partial I}{\partial s} > 0. \tag{B12}$$

B.3 Proof of Propostion 3

Point 1 We can compute

$$\frac{\partial x}{\partial \mathbf{k}} = -w \cdot \gamma \cdot (1-s) \cdot (1+r) < 0 \tag{B13}$$

$$\frac{\partial \tilde{x}}{\partial \mathbf{k}} = -w \cdot \gamma \cdot (1-s-1/N) \cdot (1+r) < 0 \tag{B13a}$$

with $\frac{\partial \tilde{x}}{\partial \mathbf{k}} > \frac{\partial x}{\partial \mathbf{k}}$, and then we can state that

$$\frac{\partial\lambda}{\partial \mathbf{k}} = \frac{\partial\Psi(x)}{\partial x} \cdot \frac{\partial x}{\partial \mathbf{k}} < 0. \tag{B14}$$

$$\frac{\partial\tilde{\lambda}}{\partial \mathbf{k}} = \frac{\partial\Psi(\tilde{x})}{\partial \tilde{x}} \cdot \frac{\partial \tilde{x}}{\partial \mathbf{k}} < 0. \tag{B14a}$$

If the the density of the shock is not increasing to the left of the mean we have that $\Psi''(.) \leq 0$ and then, since $\tilde{x} > x$ we have $\dfrac{\partial \lambda}{\partial \mathbf{k}} \leq \dfrac{\partial \tilde{\lambda}}{\partial \mathbf{k}} < 0$. It follows that

$$\frac{\partial \phi}{\partial \mathbf{k}} = \frac{\partial \tilde{\lambda}}{\partial \mathbf{k}} - \frac{\partial \lambda}{\partial \mathbf{k}} \geq 0 \tag{B15}$$

This said, by differentiating (B10) with respect to $\mathbf{k}$ we get

$$\frac{\partial I}{\partial \mathbf{k}} = \frac{q \cdot \left(B - G + \frac{P \cdot \phi \cdot (2 \cdot (q+\lambda) + \phi)}{(q+\lambda+\phi)^2}\right) \cdot \frac{\partial \lambda}{\partial \mathbf{k}} - \frac{P \cdot q \cdot (q+\lambda)^2}{(q+\lambda+\phi)^2} \cdot \frac{\partial \phi}{\partial \mathbf{k}}}{\beta \cdot (q+\lambda)^2}. \tag{B16}$$

For $B \geqslant G$ and considering (B14) and (B15) we then have

$$\frac{\partial I}{\partial \mathbf{k}} \leq 0. \tag{B17}$$

Point 1 We can compute

$$\frac{\partial x}{\partial h} = -w < 0 \tag{B18}$$

$$\frac{\partial \tilde{x}}{\partial h} = -w < 0 \tag{B18a}$$

and then we can state that

$$\frac{\partial \lambda}{\partial h} = \frac{\partial \Psi(x)}{\partial x} \cdot \frac{\partial x}{\partial h} < 0 \tag{B19}$$

$$\frac{\partial \tilde{\lambda}}{\partial h} = \frac{\partial \Psi(\tilde{x})}{\partial \tilde{x}} \cdot \frac{\partial \tilde{x}}{\partial h} < 0. \tag{B19a}$$

If the the density of the shock is not increasing to the left of the mean we have that $\Psi''(.) \leq 0$ and, since $\tilde{x} > x$, we have $\frac{\partial \lambda}{\partial h} \leq \frac{\partial \tilde{\lambda}}{\partial h} < 0$. It follows that

$$\frac{\partial \phi}{\partial h} = \frac{\partial \tilde{\lambda}}{\partial h} - \frac{\partial \lambda}{\partial h} \geq 0. \tag{B20}$$

Moreover, by differentiating (B10) with respect to h we obtain:

$$\frac{\partial I}{\partial h} = \frac{q \cdot \left(B - G + \frac{P \cdot \phi \cdot (2 \cdot (q+\lambda) + \phi)}{(q+\lambda+\phi)^2}\right) \cdot \frac{\partial \lambda}{\partial h} - \frac{P \cdot q \cdot (q+\lambda)^2}{(q+\lambda+\phi)^2} \cdot \frac{\partial \phi}{\partial h}}{\beta \cdot (q+\lambda)^2}. \tag{B21}$$

For $B \geqslant G$ and considering (B19) and (B20) it turns out that

$$\frac{\partial I}{\partial h} \leq 0. \tag{B22}$$

B.3.1 Proofs of results in Footnote 9

Let $V_E(T)$ the utility of never switching to F, $V_E^0(\underrightarrow{TF})$ the utility of immediately switching and $V_E^T(\underrightarrow{TF})$ the utility of switching at the Tth possible occasion.

We want to prove that $V_E^0(\underrightarrow{TF}) > V_E(T) \Leftrightarrow V_E^T(\underrightarrow{TF}) > V_E^{T+k}(\underrightarrow{TF})\ \forall\ T, \forall\ k$. We start showing that $V_E^0(\underrightarrow{TF}) > V_E(T) \Leftrightarrow V_E^T(\underrightarrow{TF}) > V_E^{T+1}(\underrightarrow{TF})$. Consider the choice of switching at the Teth possible occasion and the related $V_E^T(\underrightarrow{TF})$. An individual does not know exactly after how many periods the Teth occasion occurs, however we can call p_i the probability that the Teth occasion occurs after i periods (obviously $p_i = 0$ for $i < T$). The value of $V_E^T(\underrightarrow{TF})$ is then given by the sum of the expected utility in the case in which the occasion (and thus the switching) occurs after exactly i periods, multiplied for the probability of that occurrence: we can then write

$$V_E^T(\underrightarrow{TF}) = \sum_{i=0}^{+\infty} p_i V_E^{T,i}(\underrightarrow{TF}) \tag{B23}$$

where $V_E^{T,i}(\underrightarrow{TF})$ is the utility an individual gets if the Teth occasion occurs after exactly i periods. The utility $V_E^{T,i}(\underrightarrow{TF})$ is made of 2 parts: the utility the individual gets until he/she switches plus the utility he/she gets after the switch. If we call M_i the former, we have:

$$V_E^{T,i}(\underrightarrow{TF}) = M_i + \frac{V_E^0(\underrightarrow{TF})}{(1+\beta)^i} \tag{B24}$$

and then we have

$$V_E^T(\underrightarrow{TF}) = \sum_{i=0}^{+\infty} p_i M_i + \sum_{i=0}^{+\infty} \frac{p_i V_E^0(\underrightarrow{TF})}{(1+\beta)^i}. \tag{B25}$$

Note that we do not need to exactly specify neither p_i nor M_i: for the rest of the demonstration this is not necessary.

Analogously, we can write

$$V_E^{T+1}(\underrightarrow{TF}) = \sum_{i=0}^{+\infty} p_i M_i + \sum_{i=0}^{+\infty} \frac{p_i V_E^1(\underrightarrow{TF})}{(1+\beta)^i} \tag{B26}$$

where $V_{E,TF}^1$ is the expected utility from postponing the switching until the following possible occasion.

Combining the two we have

$$\begin{gathered} V_E^T(\underrightarrow{TF}) > V_E^{T+1}(\underrightarrow{TF}) \Leftrightarrow \\ \sum_{i=0}^{+\infty} p_i M_i + \sum_{i=0}^{+\infty} \frac{p_i V_E^0(\underrightarrow{TF})}{(1+\beta)^i} > \sum_{i=0}^{+\infty} p_i M_i + \sum_{i=0}^{+\infty} \frac{p_i V_E^1(\underrightarrow{TF})}{(1+\beta)^i} \Leftrightarrow \\ V_E^0(\underrightarrow{TF}) > V_E^1(\underrightarrow{TF}) \end{gathered} \tag{B27}$$

We can reformulate $V_{E,TF}^{1}$ as

$$V_E^1(\underrightarrow{TF}) = \frac{u\left(w, r\right) + \left(1 - \lambda\right) V_E^0(\underrightarrow{TF}) + \lambda V_U^1(\underrightarrow{TF})}{1 + \beta} \tag{B28}$$

where $V_U^1(\underrightarrow{TF})$ is the expected utility of a worker currently unemployed but that will switch to F as soon as he gets a job, that is:

$$V_U^1(\underrightarrow{TF}) = \frac{Eu\left(bw, \rho\right) + \delta V_E^0(\underrightarrow{TF}) + \left(1 - \delta\right) V_U^1(\underrightarrow{TF})}{1 + \beta} \tag{B29}$$

which can be rearranged

$$V_U^1(\underrightarrow{TF}) = \frac{Eu\left(bw, \rho\right) + \delta V_E^0(\underrightarrow{TF})}{\left(\beta + \delta\right)}. \tag{B29a}$$

Inserting (B29a) in (B28), we have

$$V_E^1(\underrightarrow{TF}) = \frac{u\left(w, r\right)}{1 + \beta} + \frac{\left(1 - \lambda\right) V_E^0(\underrightarrow{TF}) + \lambda \dfrac{u\left(bw, r\right) + \delta V_E^0(\underrightarrow{TF})}{\left(\beta + \delta\right)}}{1 + \beta}. \tag{B31}$$

We can now determine the condition that guarantees $V_E^T(\underrightarrow{TF}) > V_E^{T+1}(\underrightarrow{TF})$, from (B27) we can write

$$\begin{aligned} V_E^T(\underrightarrow{TF}) >& V_E^{T+1}(\underrightarrow{TF}) \Leftrightarrow \\ V_E^0(\underrightarrow{TF}) >& \frac{u\left(w, r\right)}{1 + \beta} + \frac{\left(1 - \lambda\right) V_E^0(\underrightarrow{TF}) + \lambda \dfrac{u\left(bw, r\right) + \delta V_E^0(\underrightarrow{TF})}{\left(\beta + \delta\right)}}{1 + \beta} = V_E^1(\underrightarrow{TF}) \end{aligned} \tag{B32}$$

where the right part can be arranged as

$$V_E^0(\underrightarrow{TF}) > \frac{\left(\beta + \delta\right) u\left(w, r\right) + \lambda u\left(bw, r\right)}{\lambda + \beta + \delta} = V_E(T). \tag{B33}$$

Then, combining (B32) and (B33) we can state that

$$V_{E,TF}^0 > V_E(T) \Leftrightarrow V_E^T(\underrightarrow{TF}) > V_E^{T+1}(\underrightarrow{TF}) \ \forall T. \tag{B34}$$

In addition it is easy to see that $V_E^T(\underrightarrow{TF}) > V_E^{T+1}(\underrightarrow{TF}) \ \forall T \Leftrightarrow V_E^T(\underrightarrow{TF}) > V_E^{T+k}(\underrightarrow{TF}) \ \forall T, \forall k$ so that condition (k) necessarily implies:

$$V_{E,TF}^0 > V_E(T) \Leftrightarrow V_{E,TF}^T > V_{E,TF}^{T+k} \ \forall T, \forall k. \tag{B35}$$

Condition (h) implies that whenever $V_{E,TF}^0 > V_E(T)$ we must have $V_{E,TF}^{T-N} > ... > V_{E,TF}^{T-1} > V_{E,TF}^T$ so that $V_{E,TF}^0 > V_E(T) \Rightarrow V_{E,TF}^0 > V_{E,TF}^T$.

C Determination of the pension annuities

We determine here the pension annuities p_y, with $y = T, F$, that a worker is entitled to depending on the pension scheme he chose.

In the case of TFR, we define the accrued value of contributions AV_T:

$$AV_T = w\gamma_T \sum_{t=0}^{S-1} (1+r)^{S-1-t} \tag{C1}$$

where S is the number of years of contributions (35 years in the benchmark simulation), $\gamma_T = 6.91\%$ and r is the real rate of return of the T scheme.

For the PF case, the rate of return is stochastic variable with distribution $N(\bar{\rho}, \sigma)$ and for a possible history of the returns rate $\tilde{\rho} = \{\rho_0, ..., \rho_S\}$ the accrued value of contributions is

$$AV_F(\tilde{\rho}) = w\gamma_F \sum_{t=0}^{S-1} (1 - c_F)(1 + \tilde{\rho}_t)^{S-1-t} \tag{C1a}$$

where $\gamma_F = 6.91\% + \gamma_w + \gamma_e$, that is the sum of the mandatory rate (6.91%) and the voluntary share by the worker $-\gamma_w$- and by the employer – γ_e; such values were set equal to the Italian average levels provided by COVIP (2008): 1.16% and 1.22% respectively; c_F is the administrative cost of F, set equal to 0.44% per year, according to the estimates provided by COVIP (2008). By sampling a huge number of such histories (1000000 in our case) we numerically determine the distrubition of AV_F, functional on the distribution $N(\bar{\rho}, \sigma)$ of returns, call it $\digamma\left(AV_F \mid N(\bar{\rho}, \sigma)\right)$.

Second, we compute the accrued value of the (gross of tax) annuity ($\overline{p}_y$) the individual obtains by selling on the market, in each period, the accrued value of his/her contributions AVP_y:

$$AVP_y = \overline{p}_y \sum_{t=0}^{S-1} (1+\iota)^{S-1-t} \tag{C2}$$

where ι is the real interest rate in the financial market.

By imposing the equality $AV_y = AVP_y$ and solving for $\overline{p}_y$ we get the expression for the annuity. Finally, we compute the net of tax annuity:

$$p_y = \overline{p}_y q_y \left(1 - \tau_y^c\right) + \overline{p}_y (1 - q_y)\left(1 - \tau^i\right) \tag{C3}$$

where q_y and $1 - q_y$ are the shares of contributions and of interests the accrued capital and τ_y^c and τ^i are the tax rates on these components, respectively. The τ_y^c is set to 23% for T both in the pre and post reform period and, for F, at 23% in the pre-reform and at 9% in the post-reform; the τ^i is fixed to 11% in all cases. Clearly, since AV_F is a random variable with the numerical distribution $\digamma\left(AV_F \mid N(\bar{\rho}, \sigma)\right)$ we consequentally the distribution function for $\overline{p}_F$ and p_F, with the latter being the distribution of the random annuities that a worker gets when adhering at the F.

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