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Abstract

In this paper we aim at assessing the outcomes of the 2007 Italian reform of the complementary social security and to identify the determinants behind them. The reform gave relevant incentives to workers to switch from investing about 7% of their gross wages into a compulsory defined benefit scheme inside the firm (which took the form of a termination indemnity payment, the TFR scheme) to an external pension fund. We provide a theoretical framework to model workers' choice problem of switching between these pension schemes and we then perform an agent-based simulation taking into account all the details of the reform. Our simulations are able to replicate the Italian data in term of adhesion rates to complementary social security and also to identify some of the key determinants of that outcome, like the fiscal incentives, the financial literacy and the expectations on the rate of returns of pension funds.

KEYWORDS: Pension Schemes; Second Pillar; Agent Based Simulation.

JEL CLASSIFICATION: G23, J32, E27, C63

1 Introduction

The public Social Security System (SSS from now on) in Italy will hardly be able to grant adequate pension benefits to the current generations of young workers, in particular temporary workers: after the 1990's reforms that transformed the PAYG Italian SSS from a "defined benefit" (DB) into a

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"defined contribution" (DC) 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 on the retirement age (see Table A.1, Appendix A).

In order to cope with this issue, since the first reform of SSS in 1993, the Parliament has voted several laws aiming at strengthening the second Pillar in Italy (or Complementary Social Security – CSS)[1] which, however, is still undersized, both in absolute terms and when compared to the rest of developed countries (3.5% of GDP, see Table A.2 in Appendix A). Given the relatively poor results of previous attempts, a new reform has been conceived in 2004 and implemented in 2007 in order to boost CSS for private sector employees. This reform concern the possibility of investing future termination indemnity payments[2] (Trattamento di Fine Rapporto - TFR) into the CSS (in particular into external Pension Funds, PF henceforth) 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. The reform outcomes appeared somehow puzzling in two aspects: first, observed adhesion rates to CSS have been low (only 26% of potential private sector subscribers by the end of 2008 according to official data). Second, the adhesion rates are positively correlated with firms' size. These results could be transitory, due to the recent negative performances of financial markets and to the lack of information among employees; however, it might also be a consolidated phenomenon, casting doubts on the long run effectiveness of the reform. The results are also worrying if we consider that about 54% of the Italian labour force are employed in firms with less than 50 workers, so that such an outcome implies a polarization in the choice of adhesion, with the risk that a large share of employees could live their retirement period with insufficient economic resources. This paper wants to address the results of this reform, shedding lights on the consequences for both workers and firms and trying to identify the determinants of its outcomes.

From a broader point of view, similar reforms have also been implemented in several other OECD and South America countries, where the DB scheme has usually been replaced, completely or partially, by other schemes, in some case run by the private sector (see Whiteford and Whitehouse 2006

[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.

[2]The current TFR italian system consists in an amount of money that is witheld by the firm and given to the workers (revaluated at a certain rate) only at the moment of the job termination. Some anticipation of these amounts are possible in special circumstances (for example during unemployment spells, to cover health expenditures, to buy a house and so on).

for OECD countries and Mesa-Lago 2006 for South America). In some of those countries workers had to choose between different pension schemes, facing a decisional problem which shared some aspects with the Italian case. While in this paper we focus the analysis on the Italian case, the methodology we propose can be applied to analyse and evaluate the reforms of other countries.

The heart of the issue we are tackling is the decisional process of workers facing different pension schemes. This aspect has not been studied in details in the literature, even if some empirical analysis on partly similar issues exist: for example, Mitchell et alii (2008) try to assess the determinants of the choice between different private pension funds in Chile, stressing the role of financial illiteracy and Butler and Teppa (2007), investigate the determinants behind the individual decisions to annuitize or to cash out accumulated pension capital in Switzerland[3].

As for the Italian case, the 2007 reform has been analyzed by some authors, though a full assessment is still to be done. On the individuals' side, Cozzolino et al. (2006) in an empirical study show that only 21% of Italian householders interviewed by Bank of Italy SHIW in 2004 considered the public sector pension adequate, although among these individuals only 23% regarded as useful the adhesion to a Pension Fund. Interestingly enough, on the basis of a survey carried out by ISAE in 2004 and 2005 on the CSS reform, the authors show that the share of individuals willing to maintain future TFR in the firm increased from 40% to 53% between 2004 and 2005. The authors impute such an increase to the irreversibility of the choice of switching to CSS (introduced in 2005). Moreover, 56% of interviewed individuals considered the fiscal rebates provided by the reform as unsatisfactory. Cesari et al. (2007) quantify the economic incentives provided by the reform to adhere to CSS and unveil that such incentives are relevant not only because of the fiscal rebates, but also for the presence of the "employer contribution", the latter representing a "windfall gain" for the employee.

On the firms' size, Bardazzi and Pazienza (2005) carry out simulations aiming at estimating the cost of the reform for Italian firms. They conclude that such a cost would add up to 5% of total wages in ten years, and that, both taking into account the interest rate structure of loans and the size of the TFR stock currently held by the firms, such a cost is inversely related with the firms' size.

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. Their analysis follows the evidence provided by Pazienza (1997) and Guiso (2003) according to which the size is a strong

[3]Of course there is a large literature that investigates on the characteristics of the different pension schemes without focusing in particular on the choice problem; 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).

determinant of the success in obtaining credit from banks in Italy (see also Palermo and Valentini 2000 and Capitalia 2005 on the financial structure of Italian firms). In the light of these results much concern persists on the effectiveness of the compensation measures conceived by the law for reducing the negative impact of the foregone TFR on the financial costs for firms (see Pammolli and Salerno 2006).

Although effective in highlighting the risk for SME's financial health brought about by the reform, the literature up to now has overlooked the role that such a factor will exert on the workers' incentives to adhere to CSS. A partial exception is represented by Garibaldi and Pacelli (2008), in which they work out a model entailing a positive relationship between TFR withdrawals and the risk of being fired by the firm. According to their estimates, the authors argue that the 2007 reform will increase the probability of job termination by 10% in the first year for an individual adhering to CSS. Moreover, their data show that withdrawing is more likely the larger the firm employees work in. The paper, although interesting, does not take into account that such higher risk of unemployment is likely to be a key determinant in the choice of individuals as to whether adhering or not to CSS. However, in our opinion this aspect (the risk of unemployment) is likely to play a relevant role in the Italian economy, where the vast majority of firms (more than 90%) are concentrated in the 1-20 dimensional class and that neither the labour nor the financial market are perfectly competitive.

In our work we try to fill this gap in order to explain, on the one hand, the reasons for the partial failure of the reform and, on the other hand, the positive correlation between the firms' size and the adhesion rates. First we describe a theoretical framework, based on Corsini et alii (2010), which addresses the role that the TFR stock has for the firm and the decision problem faced by workers after the introduction of the TFR reform. We then use this framework as the base for an agent-based simulation which aims to replicate the outcomes of the reform and to understand which aspects are particularly important in explaining those outcomes. Finally, we aim at performing some forecasts on the possible future scenarios of reform at the regime phase.

The work is organized as follows: after presenting the institutional setting of the Italian CSS and the 2007 reform, we lay out the baseline theoretical framework used to determine the economic incentives according to which individuals decide whether adhering or not to CSS. On this basis we specify a agent-based simulation model to replicate the main features of the Italian economy and to explain the outcomes of the reform as well as to provide some future forecasts of them.

2 The situation of CSS in Italy after the recent reforms

2.1 The institutional framework

As anticipated, the dimensions of the second pillar in Italy are very small. As Table A.2 in the appendix shows, the assets managed by CSS amount to 3% of GPD in 2006 (almost 3.5% in 2008). Given the worrying perspectives of the state pension scheme, the Italian Parliament has voted in past years several measures aimed at enhancing supplementary pensions, measures which however have been scarcely effective. Thus, in 2004 the law 243, and the subsequent implementing decrees 252/2005 and 296/2006 have introduced a new reform for private sector employees, which entails the possibility of devolving future contributions for the severance fund (the TFR) to the CSS.

The TFR is regulated by the article 2120 of the Civil law Code (Codice civile) which states that each firm has to put aside, for each tenured worker (hence, "atypical" workers are excluded), about 1/13th of gross salary per year. Since such contributions are capitalized at 1.5% per year plus 75% of the inflation rate, until now from the firms' point of view the TFR fund has represented a cheap source of financing (consider that such a yield has been lower than the risk-free rate of Treasury bonds in most of the past years).

Moreover, employees have the possibility to partially withdraw from such a fund, although under very specific conditions: only once, after at least 8 years of employment, up to 70% of the stock and given that withdrawing employees in each year cannot exceed 10% of the entitled employees and 4% of the workers of the firm as a whole. These withdrawals are allowed, for example, for the purchase of a house (either by the worker or by the worker's children), for medical expenditures and so on. As for fiscal treatment, besides contributions being tax exempt for both firms and employees, the annual re-evaluation of the stock is taxed by 11% (lower than the 12.5% tax rate for the returns produced by other financial investments). Finally, upon worker's dismissal, either voluntary or involuntary, the worker has the right of obtaining the whole stock of the TFR: such an amount of money (net of already taxed returns) is taxed at a fixed, favourable rate (the average of last 5 years mean-tax rate on personal income, typically about 23%).

In order to make the switch from TFR to CSS less traumatic or, in any case, more attractive for workers, the reform has, on the one hand, allowed the possibility of withdrawing from the personal fund every 7 years and for specific reasons (either partially or, in some cases completely, for example after 4 years of unemployment), similar to the ones applying to TFR. On the other hand, a particularly favourable fiscal treatment for CSS has been introduced: more precisely, while contributions continue to be tax-exempt and returns taxed at 11%, the cumulated value of the investment obtained

upon retirement (at most 50% cash, while the other part must be converted into an annuity) is taxed at 15% rate, with a further 0.3% reduction per each year beyond the 15th of contribution to CSS (and the minimum rate being 9%, granted after 35 years of adhesion to CSS). Finally, the law explicitly allows for the possibility of receiving the "employer contribution", provided that the employee adds a voluntary contribution on top of the 6.91% (currently these contributions amount to 1.16% and 1.24% of gross wage respectively).

As far as firms are concerned, in order to partially offset the potential harmfulness of the reform for the financial solidity of enterprises, the legislator has, first of all, provided tax exemptions for contributions transferred to CSS. Moreover, it has differentiated the regulation of contributions maintained inside the firm by the workers, according to the firm's size. In particular, for "small firms" (that is, with less than 50 workers) these contributions will in fact remain inside the firm, while for "large firms" (employing more than 50 workers) they will be transferred to a State fund ("Fondo di Tesoreria" of INPS, the Institution managing Italian Social Security) and, hence, will be lost by the firm in any case, no matter the decision of the employee.

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

In fact, the adhesion rates, after two years, are clearly unsatisfactory. As shown by Table 1, from 2006 to 2007 the rate of subscription to CSS has increased from 16.28% to 25.11% and nearly became 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 (source: our computations based on 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 2). These 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: for this reason, in the remainder of the paper we will use these data for our simulations. 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.

	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 (source: our computations based on COVIP data)

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

3 Modelling the choice process

We give here a brief theoretical foundation of the process underlying workers' choose on pension plans. We base our model on Corsini et alii (2010) where full details can be found. The basic idea behind this model is that workers have to choice between two different pension schemes: (i) a safe return scheme inside the firm (called TFR or T henceforth) or (ii) a DC scheme external to it (called PF or F henceforth). In this choice, workers not only have to weight out the rates of return and variability of the schemes, but they also have to consider that investing their money inside or outside the firm has relevant consequences on the very firm and, through it, on the worker career.

3.1 The basic framework and the role of the TFR stock

We imagine an economy populated by identical agents and firms. All firms employ N workers (N will be taken as a measure of the size of the firm), adopt an amount of capital H (with h being the ratio of capital over total wage bill) and use the same technology for the production of a commodity Y (the numeraire) in a regime of perfect long run competition. Workers are paid at gross wage w and capital is rewarded through the distribution of dividends. Their production activity is subject to exogenous random shocks.

Workers can be in two possible states: they can be employed in one of the above firms in which case they receive the wage w or they can be unemployed, in which case they receive a unemployment subsidy b; in either case they invest 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. The amount contributed is the same (a fraction γ of income) for both schemes, but returns are different: a safe return r in the case of T and an uncertain return ρ in the case of F. If we define $\mathbf{k}$ the average number of periods that a worker has been contributed in the firm and s the share of worker that has switched to the F scheme, then the T stock per worker in each firm is $\gamma \cdot w \cdot \mathbf{k} \cdot (1-s)$.

Firms use their production to cover their costs: the total wage bill and the remuneration of the capital stock[4] and, given perfect competition, average total production is equal to total costs. However, whenever the production value is below costs, firms do not immediately go bankruptcy; rather, there are some financial sources which they can use to cover the losses: first, they may not pay out dividends, second, they can access the credit market where they receive credit within the limits of the collaterals that they can provide to the bank (and we assume that the collaterals are the assets available within the firm) and third, they can use the TFR stock present within the firm. These three sources make up the total amount of negative profits they can sustain before going bankrupt, in which case all the employees lose their job. If we define $\Psi(.)$ the cumulative distribution function of the average production, the firms' probability of going bankrupt is given by:

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

The amount in the brackets represent the lowest average productivity that a firm can stand without going bankrupt: it basically depends on the size of the financing sources: the amount of capital $w \cdot h$ which can be used as guarantee to obtain credit and the TFR stock $\gamma \cdot \mathbf{k} \cdot (1-s)$. The remuneration of capital does not enter the equation because it constituites both a cost and an indirect financing source (when divedends are not paid out) so that in the end it cancels out.

Equation (1) also determines the probability for a given worker of losing his current job and it also shows the effect of the choice of the pension scheme on his current career: in fact his switching to the F scheme increases the share s by $1/N$, so that the new probability is

$$\tilde{\lambda} = \Psi\left(w \cdot \left[1 - \gamma \cdot \mathbf{k} \cdot \left(1 - s - \frac{1}{N}\right) \cdot (1+r) - h\right]\right) \tag{2}$$

[4]In truth also the remunaration of the TFR stock should be taken into account 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.

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* that a worker produces by switching to F and depends among other things on N and s (that is $\phi = \phi(N, s)$) . Since the increase in the starting share of adhesion is smaller the greater the size of N is, it is easy to show that the damage is greater in smaller firms and became negligible when firms are large enough (see Corsini et alii (2010)).

3.2 Workers' choice

As already stated, 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). In their choice they have to weight out the different average rates of return of the schemes (r for the T scheme and $\bar{\rho}$ for the F scheme), the variability of those returns (which is 0 in case of the T scheme) and the damage ϕ that they have from the switching, which, as shown above, is the increase in the probability of losing the job.

We can determine the lifetime utility of the two possibilities through the use of a basic job searching model, augmented to take into account that a workers might work under the T or F scheme. If he stays at the T scheme his expected lifetime utility $V_E(T)$ can be written as:

$$V_E(T) = \frac{u(w, r) + \lambda \cdot [V_U(T) - V_E(T)]}{\beta} \tag{3}$$

where $u(w, r)$ is the period utility (which increases in both w and r), β is the discount rate and $V_U(T)$ is the expected lifetime utility for an unemployed worker which is still at the T scheme.

If he switches to the F scheme, his expected lifetime utility $V_E(\underrightarrow{TF})$ is given by:

$$V_E(\underrightarrow{TF}) = \frac{Eu(w, \rho) + \tilde{\lambda} \cdot \left(V_U(\underrightarrow{TF}) - V_E(\underrightarrow{TF})\right)}{\beta} \tag{4}$$

where $V_U(\underrightarrow{TF})$ is the expected lifetime utility for an unemployed worker that has switched to the F scheme.

The main difference between the two equations are the (expected) utility that they enjoy in each period and the probability of losing the job (which is higher in the second case).

The two equations can be solved through recursive methods, and if we define as I the difference between the expected lifetime utility of switching and that of not switching, we obtain[5]:

[5]Here we are somehow assuming that a worker is not considering the possibility of

$$I \equiv V_E(\underrightarrow{TF}) - V_E(T) = \frac{1}{\beta \cdot (q+\lambda)} \left(q \cdot G - q \cdot \frac{1}{\frac{q+\lambda}{\phi(N,s)} + 1} \cdot P + \lambda \cdot B \right) \tag{5}$$

where $q = \beta + \delta$, $G = Eu(w,\rho) - u(w,r)$, $P = Eu(w,\rho) - Eu(b,\rho)$, $B = Eu(b,\rho) - u(b,r)$, δ is the probability to find a new job when unemployed and b is a measure of the unemployment benefits.

The above gives us the incentive function of workers, and they will switch to the F scheme if and only if $I > 0$.

The sign of the incentive function (5) depends on the sign and the magnitude of the terms G, P and B and, under some given assumption, it is possible to derive some general properties. Corsini et alii (2010) discusses in details these properties and the underlying assumptions, here we just point out two of the main results:first, the incentive is an increasing function of firms' size; second, for large enough N, the incentive is positive whenever $Eu(w,\rho) > u(w,r)$. In other words, in larger firms, workers will switch from T to F scheme whenever the direct direct utility from the latter is higher than from the former, while in smaller firms, this condition is not enough.

4 The simulation strategy

The model examined in the previous section 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 and delivered an equation for I whose value determined the choice of workers. However it has to be improved in at least four aspects:

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)

simply postponing the switch to a future period. However it can be shown that this third possibility is always suboptimal, see (Corsini et alii (2010)).

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 equation (5), the 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.

4. the scheme T and F do are not only different for their rate of returns, but also for several details, some of which were introduced with the 2007 reform. The model above is too stylized to take into account the full complexity of the different schemes, but if we want to fully assess the role of the reforms, an explicit consideration of all the details 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.

4.1 Workers

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

$$W_i = \{a_i, \beta_i, j_i, \alpha_i, H_i\} \quad \forall i \in \Im \tag{6}$$

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[6];

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.

4.1.1 Consumption levels and instant utilities

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

$$u_i(c) = \frac{c^{a_i}}{a_i} \tag{7}$$

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 3, 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[7] 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[8]

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

[6]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.

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

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

4.1.2 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

$$\epsilon_i(t+1) = \epsilon_i(t) \cdot (1 - \lambda_{j_i}) \tag{8}$$

$$\eta_i(t+1) = \eta_i(t) \cdot (1-\delta) + \lambda_{j_i} \cdot \epsilon_t + \Lambda_i \cdot \theta_i(t) \tag{8a}$$

$$\theta_i(t+1) = \theta_i(t) \cdot (1 - \Lambda_i) + \delta \cdot \eta_i(t) \tag{8b}$$

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 dynamic system has a solution

$$\epsilon_i(t) = (1 - \lambda_{j_i})^t \quad \forall t \geq 0 \tag{9}$$

$$\eta_i(t) = \begin{cases} 0 & \text{for} \quad t = 0 \\ \lambda_{j_i} & \text{for} \quad t = 1 \\ \frac{\left((1-\lambda_{j_i})^t - 1\right)\cdot(\lambda_{j_i} - \Lambda_i)\cdot\Lambda_i + \delta\cdot\left((1-\lambda_{j_i})^t\cdot(\lambda_{j_i}-\Lambda_i) - \lambda_{j_i}\cdot(1-\delta-\Lambda_i)^t + \Lambda_i\right)}{(\delta+\Lambda_i)\cdot(\delta-\lambda_{j_i}+\Lambda_i)} & \text{for} \quad t \geq 2 \end{cases} \tag{9a}$$

$$\theta_i(t) = \begin{cases} 0 & \text{for} \quad t < 2 \\ -\frac{\delta\cdot\left(-\delta+\lambda_{j_i} - \lambda_{j_i}\cdot(1-\delta-\Lambda_i)^t - \Lambda_i + (1-\lambda_{j_i})^t\cdot(\delta+\Lambda_i)\right)}{(\delta+\Lambda_i)\cdot(\delta-\lambda_{j_i}+\Lambda_i)} & \text{for} \quad t \geq 2 \end{cases} \tag{9b}$$

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, of the financial conditions of any firm in which he can happen to enter.

4.1.3 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

$$Eu_{i,t}(T) = (\epsilon_i(t) + \theta_i(t)) \cdot u_i(w, r) + \eta_i(t) \cdot u_i(b, r) \tag{10}$$

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

$$V_{E,i}(T) = \frac{u_i(b,r)\cdot\lambda_{j_i}\cdot(\beta_i+\Lambda_i) + u_i(w,r)\cdot\left(\beta_i^2+\delta\cdot\lambda_{j_i}+\beta_i\cdot(\delta+\Lambda_i)\right)}{\beta_i\cdot(\beta_i+\lambda_{j_i})\cdot(\beta_i+\delta+\Lambda_i)} \tag{11}$$

which simplifies to (3) 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

$$Eu_{i,t}(F) = \left(\tilde{\epsilon}_i(t) + \tilde{\theta}_i(t)\right)\cdot Eu_i(w,\rho) + \tilde{\eta}_i(t)\cdot Eu_i(b,\rho) \tag{12}$$

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

$$V_{E,i}(\underrightarrow{TF}) = \frac{u_i(b,r)\cdot\tilde{\lambda}_{j_i}\cdot(\beta_i+\tilde{\Lambda}_i) + u_i(w,r)\cdot\left(\beta_i^2+\delta\cdot\tilde{\lambda}_{j_i}+\beta_i\cdot(\delta+\tilde{\Lambda}_i)\right)}{\beta_i\cdot(\beta_i+\tilde{\lambda}_{j_i})\cdot(\beta_i+\delta+\tilde{\Lambda}_i)} \tag{13}$$

which simplifies to (4) when we assume $\tilde{\Lambda}_i = \tilde{\lambda}_{j_i} = \tilde{\lambda}\ \forall i \in \Im$.

4.2 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:

$$A_j = \{h_j, \mathbf{k}_j, \theta_j\} \quad \forall j \in J \tag{14}$$

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;

4.3 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.

4.4 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[9].

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

5 An Assessment of the Italian 2007 Second Pillar Reform

In this section we apply the methodology described in the previous section to give an assessment of the Italian 2007 reform. In order to pursue this goal, we have to fix proper values for the basic parameters of the model; thus we give below an account on the strategy we followed to set them.

5.1 The setting of base parameters

The parameters of the model define all the details concerning the agents, the system and the reform. 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 unreasonable values[10].

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 this point 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 deviations 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

[10]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.

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 (**k**) and the ratio of own capital over total wage bill (h), both measuring how 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 PF over total private sector employees, so that it measures the probability that a worker can effectively subscribe to an occupational PF which grants 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 term 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

5.2 Simulation results

We present now the results of the simulations, performed according to the strategy presented above. Two features of the results are worth mentioning. First, the equilibrium value of s is significantly dependent on the size of the firms, with bigger firms displaying higher values of the adhesion rates. Second, the level of the adhesion is quite low, failing to reach a consistent share of the population.

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 and confirming the scarce attractiviness of the new scheme.

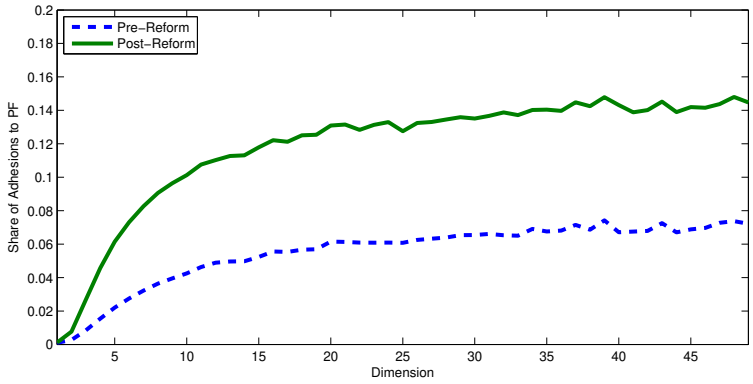

Figure 1: Adhesion rates before and after the reform

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

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 outcomes) 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 shedding 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 2, 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

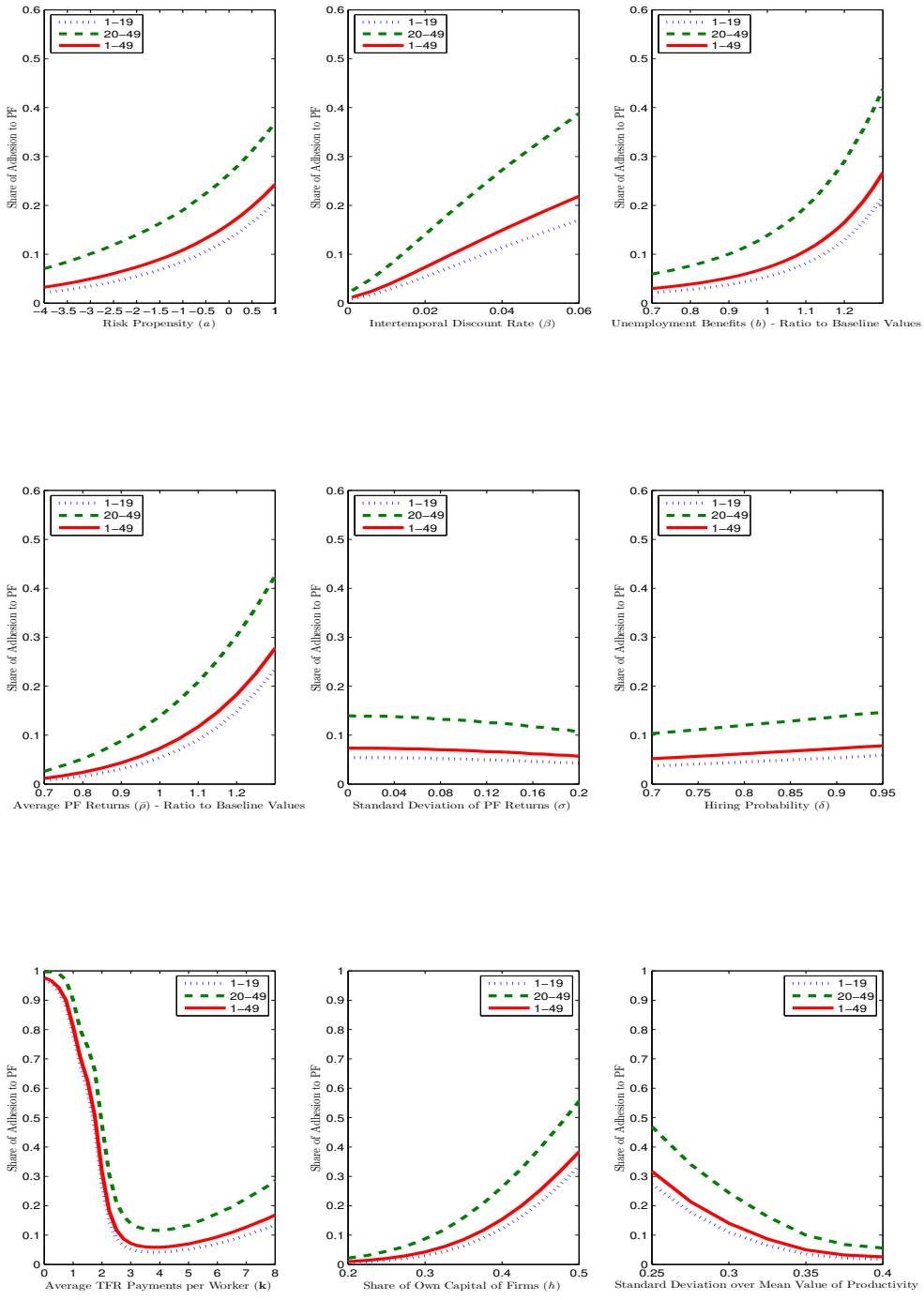

Figure 2: Sensitivity analysis for some key parameters

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 probability 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 not particularly large (according to our parameters, the pension payments amount to 5-7% of the gross wage) and is generally outweighed by the loss in case of unemployment.

Finally, the role of $\mathbf{k}$, 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 2, its effect on the adhesion rates is not monotonic and, more precisely, is U shaped. The reason is that, when $\mathbf{k}$ 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 $\mathbf{k}$, while it is offset for higher values of $\mathbf{k}$.

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. To explore the former, we simulate the model allowing for different PF nominal returns and we extend the simulation periods from 2 to 15 iterations, so that the reform has enough time to display its full effect; for the latter, we allow for different degrees of information, a more"normal" PF nominal returns (4.5%, in line with the last decade value) and extend the periods from 2 to 15 iterations. Figures 3 and 4 show the results of such an exercise.

According to our simulations, and in line with what we expected, the rate of return of the PF scheme has an important effect on the adhesion rates but only when the latter is above 6% (that is only for extremely optimistic rate of return), we observe a relevant value of the adhesion rate: from this point of view our results suggest that the current adhesion rates will stay quite stable even after the 2008 financial crisis is fully over. As for the role of the α parameter, that is the share of those workers that, having a positive incentive to switch from TFR to PF, effectively 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

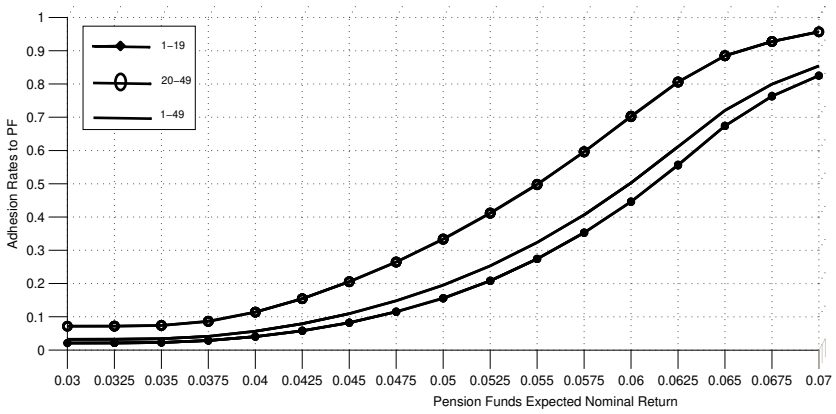

Figure 3: Long run outcomes for different expected returns of PF

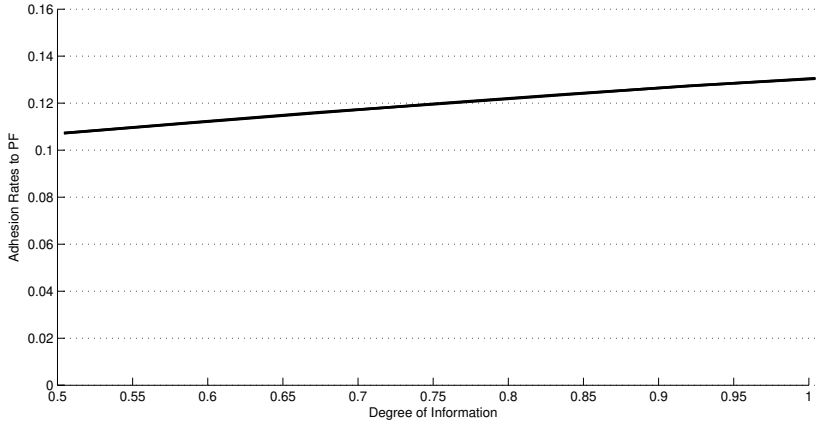

Figure 4: Long run outcomes for different degree of information

would be boosted up to 13%, which shows that results are rather insensitive to such a parameter. This latter result is interesting also because it may be used to evaluate the effect of policies aimed at a greater diffusion of the knowledge of the reform or of financial literacy.

Finally, in the attempt of showing the potential of our simulation from a policy point of view, we present 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 5) 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.

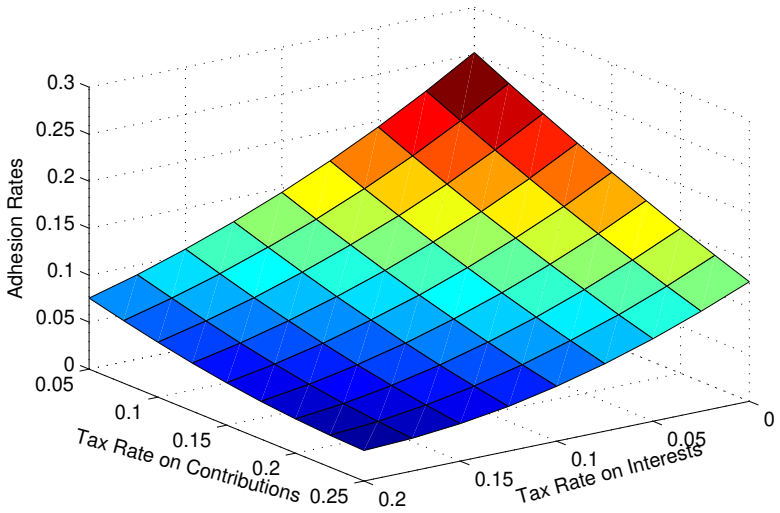

Figure 5: Adeshion rates for different levels of taxation

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.

6 Conclusions

The aim of this work was to explain the results of the Italian 2007 reform in terms of adhesion to CSS, providing an explanation of the mechanics behind it and identifying the key determinants of the scarce observed adhesion rates. We adopted a model representing the decisional process of workers when choosing between different pension schemes and we used it as the theoretical background on which to build an agent-based simulation able to take into account all the details of the reform and to replicate its outcome. The key element of the decisional process rests in the fact that workers have not only to consider the direct economic advantages and disadvantages (consisting in higher but riskier returns) of the different schemes, but also 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 on the financial health of the firm.

The simulation of the model allows to examine the aggregate outcomes stemming from individual decisions, taking explicitly into account the heterogeneity of firms' and agents' characteristics. Under some simplifying assumptions on agents' expectations formation process, we were able to replicate quite well all the outcomes and in particular, we obtained the positive significant relation between the rate of subscription to the PF scheme and the size of the firm that we observed from the empirical evidence. The sensitivity analysis shows that adhesion rates are particularly sensitive to unemployment benefits, to returns from the PF and to the variability of the productivity shocks. We also used our simulation can also be used to perform exercises on the effect of policies aimed at boosting the adhesions. Indeed, our simulation suggests that 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. On the contrary, fiscal policy seems to be, through the

fiscal incentives, an important determinant of the final 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.

Finally, we tried to assess whether the observed outcomes should be considered transitory and strictly dependant on the 2008 financial crisis: we then allowed more optimistic scenarios regarding the returns from PF but the results were not overthrown, so that the expected adhesion rates in the regime phase of the reform seem to still fail in reaching significant values.

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	70-80	58.46-66.82	35.43-40.49	54.18-61.47	32.83-37.25
62		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 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:

$$AV_T = w\gamma_T \sum_{t=0}^{S-1} (1+r)^{S-1-t} \tag{B1}$$

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

$$AV_F(\tilde{\rho}) = w\gamma_F \sum_{t=0}^{S-1} (1-c_F)(1+\tilde{\rho}_t)^{S-1-t} \tag{B1a}$$

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 –γ_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 distribution of AV_F, functional on the distribution $N(\bar{\rho}, \sigma)$ of returns, call it $\digamma(AV_F \mid N(\bar{\rho}, \sigma))$.

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:

$$AVP_y = \overline{p}_y \sum_{t=0}^{S-1} (1+\iota)^{S-1-t} \tag{B2}$$

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:

$$p_y = \overline{p}_y q_y \left(1-\tau_y^c\right) + \overline{p}_y (1-q_y)\left(1-\tau^i\right) \tag{B3}$$

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 $\digamma(AV_F \mid N(\bar{\rho}, \sigma))$ we consequently 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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