Main Determinants of Profit Sharing Policy in the French Life Insurance Industry*

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Abstract. In this paper, we analyze the main drivers explaining the evolution of participation rates for French savings contracts over the period 1999-2013. We use a brand new data set of participation rates built from supervisory reports. At this stage, our results, relevant for medium-size and large life insurers, are in line with practitioners' insights and show the strong roles of government bonds rates, asset returns, lapse rates and profit sharing reserves. Interestingly, we also observe a high degree of auto correlation in participation rates. Our preliminary findings improve the understanding of the profit sharing policies implemented by insurers and might be used to anticipate the market rate in absence of change of regime.

Keywords. participation rate, *taux de revalorisation*, profit sharing policy, life insurance, panel data, regulatory database.

*The views expressed in this paper are those of the authors and do not necessarily reflect those of the Autorité de Contrôle Prudentiel et de Résolution (ACPR), neither those of the Banque de France.

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1 Introduction

The participation strategy used by French life insurers for their euro-denominated savings contracts with profit participation has seldom been studied. This comes from the fact that life insurance markets are less "standardized" than property and casualty markets. Savings contracts are very different from one country to the other, in terms of minimum guaranteed rates as well as in legal terms. France is characterized by relatively low guaranteed rates in comparison to other European countries, which makes the participation strategy all the more so important. In most countries, insurers are required by law to declare at the beginning of the year the bonus that will be given at the end of the year. In other countries, like France, bonus participation is decided at the end of the considered period, after observing the realized risk factors of the year and in some cases the first decisions of some competitors. Legal, fiscal, accounting and regulatory environments vary from one country to the other. Even if Solvency II is supposed to bring more standardization, there will still remain some differences, in particular regarding the way to build the "stability reserves" (such as the *réserve de capitalisation* in France), and the legally binding minimum profit-sharing rules.

Most authors interested in this matter point out that participation strategies depend not only on the present and past performances of the insurer's strategic asset allocation, but also on policyholders' expectations (in terms of performance and regularity), on the characteristics of the insurance portfolio, on the insurer's ability to smooth its financial results, on other insurers' behaviors and on the set of substitute products available on the market. However, almost all authors address these issues with an *a priori* assumption on the profit sharing management rules (mainly for valuation purposes). There is a clear lack of empirical literature studying these behaviors both in France and in other countries.

For a supervisor, it is essential to understand the participation strategies in order to be able to pin down potential vulnerabilities for insurers which would face too stringent a constraint and could not honor their liabilities or face competition. It is all the more so important to get a clear picture of the empirical factors explaining how the participation rate is fixed given the weight of life insurance in the French insurance industry[1]. In the present paper, we attempt to bridge this gap and carry out the first empirical study of participation strategies in the French market with new panel data coming from the French insurance and banking supervisor, namely the *Autorité de Contrôle Prudentiel et de Résolution* (ACPR). To the best of our knowledge, similar studies have not yet been conducted in other countries.

In the present paper, we compile new panel data drawn from supervisory reports to try to understand which drivers explain the average participation rates (in French, *taux de revalorisation*) observed at the firm level for euro-denominated participating contracts on the domestic market. We follow a classical empirical strategy with econometric regressions. Because participation rates seem to be influenced by economic variables that are common

[1] In 2013, mathematical reserves (MRs) in life insurance with participation added up to more than EUR 1.4 trillion, that is about 70% of the French GDP (http://acpr.banque-france.fr/publications/rapports-annuels/chiffres-du-marche-francais-de-la-banque-et-de-lassurance.html).

to all insurers, and because stability over time and policyholders' expectations seem to be important, we study the participation rate offered by each insurer compared to a reference rate for that year.

Thanks to various robustness and time-stability checks, the main contribution of our paper is to give an objective, empirical assessment of the main drivers that really impact the participation rates offered by French insurers on their euro-denominated participating contracts. In the future, we aim at identifying different types of insurer behavior and proposing new ideas to assess insurers' potential vulnerabilities.

The paper is organized as follows. In Section 2, we conduct a review of the (limited) related literature in insurance, and extend it to other fields of research with potentially inspiring models. We briefly describe the French regulatory context in Section 3. In Section 4, we introduce the database, define and characterize the most relevant variables, and provide a first attempt to graphically analyze the information contained in the data. In Section 5, we develop the econometric models that are tested in Section 6. Several robustness and stability checks are proposed in this penultimate section. Section 7 concludes.

2 Literature review

2.1 Main contributions on participation and their motivations

Some authors, like Grosen and Løchte Jørgensen (2000), Hansen and Miltersen (2002) or Ballotta *et al.* (2006) are interested in the fair value of savings contracts. Therefore, they try to evaluate policyholders' options, including the surrender option. Depending on the considered regulatory constraints, American or barrier options naturally appear, when policyholders are assumed to feature financial rationality. Zemp (2011) compares the estimations and models the risks faced by an insurer for different participation strategies.

Other authors like Planchet and Thérond (2007) consider risk management or asset-liability management and make assumptions on participation strategies. Bauer *et al.* (2006) and Hainaut (2009) determine optimal participation strategies using dynamic programming and optimal control techniques *à la* Hamilton-Jacobi-Bellmann in a stylized German framework or in a simplified model. Bohnert and Gatzert (2012) compare the insurer's default risk and potential advantages for policyholders associated with different profit-sharing schemes.

In terms of mechanisms, Bacinello (2001) presents an Italian participation system based on the pure asset return of the insurer's financial portfolio, without stability reserve or time-smoothing method. Haberman *et al.* (2003) introduce among others a British system based on the arithmetic mean of the previous returns, that has been used by British insurers to smooth the rate offered to policyholders. Grosen and Løchte Jørgensen (2000) consider a Danish regulatory framework and constitute a kind of stability reserve, which is contributed to during good years and used as a compensation source in bad years. In this approach, participating bonuses are more guided by the level of this reserve than by asset returns. Hansen and Miltersen (2002) enhanced this work by adding a terminal bonus and a yearly management fee. In the German context, Bauer *et al.* (2006) and Kling *et al.* (2007) nicely combine a target participation rate and the care for maintaining high enough reserves.

2.2 French market specificities

These interesting models do not adequately take into account the specificity of the French market. Indeed, the discretionary feature of the participation strategy is more important in France, especially because guaranteed rates are lower than in most other countries. The concept of reserves, that is present in many papers, only grossly captures some of the various smoothing and financial risk management mechanisms authorized by the French regulatory framework[2]. The complexity of the constraints (e.g., amounts placed in the profit sharing reserve – PPB – must be distributed to policyholders within 8 years to avoid penalties) makes it almost impossible to take into account all the aspects of the French regulatory framework in a simple, systematic way.

Besides, the aforementioned papers deal with homogeneous portfolios of open or closed (to new entries) contracts. Thus they do not consider mixed portfolios (of both open and closed contracts), with different opening dates and varying minimum guaranteed rates. They do not either consider that an insurer may have different collection (or decollection) objectives for the various contracts of its portfolio. This heterogeneity naturally leads the insurer to choose a global strategy involving different sub-strategies by types of policyholder and product when this is legally feasible. Even if our dataset is not granular enough[3], we are able to capture part of this heterogeneity in our paper with fixed effects.

2.3 Potential links between participation and other variables

2.3.1 Asset returns

Asset returns and average term interest rates remain of course very important explanatory variables for participation strategies in empirical studies (see Gandolphe, 2014), in theoretical approaches directly linked to asset returns like the one of Bacinello (2001), or when one monitors a kind of stability reserve like in Grosen and Løchte Jørgensen (2000), because the

[2]This framework includes Articles R.332-19/20 of the *Code des Assurances* regarding latent asset profit and loss, Article A.333-3 of the *Code des Assurances* regarding the *réserve de capitalisation*, as well as Articles A.132-5 and following and Article R.331-3 regarding profit sharing rules and management of the *provision pour participation aux bénéfices* (PPB).

[3]We do not have participation rates at the contract level before 2008.

evolution of this reserve is strongly influenced by present and past asset returns and interest rate levels.

In her descriptive statistical analysis of participation rates on the French individual savings market in 2013, Gandolphe (2014) shows graphically the link between the average participation rate proposed by French insurers between 2007 and 2013 and the 10-year French government bond rate (*Obligation Assimilable du Trésor* or OAT-10Y). This relation is also used by several authors, including Planchet and Thérond (2007), for whom participation strategies are part of an insurance company's toy model for Asset-Liability Management (ALM) purposes. In this approach, when financial products are too small, one uses the money available in the *provision pour participation aux bénéfices* (PPB), realizes potential latent asset profits, and consumes part of the own funds if necessary (in a pre-defined limit). This corresponds to the willingness to smooth the rates offered over time, in line with what Bauer *et al.* (2006) call the average interest principle.

2.3.2 Stability reserves

Bauer *et al.* (2006) study the impact of the insurer's initial financial situation on her ability to smooth future participation rates. They advise policyholders to select an insurer that combines interesting guaranteed rates and large enough initial reserves. Regularity often becomes an optimization objective in the literature: Planchet and Thérond (2007) show that participation rates are less volatile in presence of dynamic strategic asset allocation than with a static one. In Grosen and Løchte Jørgensen (2000), Bauer *et al.* (2006) and Gerstner *et al.* (2008), one or several reserves are used to tackle this smoothing objective. The reserve is often managed by offering the maximum between the guaranteed rate and the rate that would enable the reserve to come back to the targeted safety level with a given mean-reverting speed.

The target safety level is a concept similar to that of a target solvency coverage ratio which some insurers try to reach under Solvency II. In a more general framework, optimal dividend strategies and profit-sharing mechanisms have been studied by economists like Lintner (1956) and by actuarial scientists in risk theory, starting with De Finetti (1957)'s risk model with horizontal dividend barrier. A survey of optimal dividend strategies in a more general framework is available in Avanzi (2009). However, profit-sharing mechanisms proposed by Grosen and Løchte Jørgensen (2000) and by Gerstner *et al.* (2008) rather look like the so-called band strategies, in which retained premium (or dividend payments) depend on the insurer's current surplus level.

2.3.3 Policyholders behavior

A key driver of the participation strategies is the policyholders' behavior. In particular, the way they may react to irregular participation rates or to a decreasing trend is very important for the insurer. Due to the lack of available data, most French authors like Planchet and Thérond (2007) assume that surrender rates follow the specifications given by experts, or depend in a simple manner from the difference between the offered rate and the "market rate". Of course, it is very challenging to define this "market rate" or the policyholders' expected rate. Policyholders' behavior in life insurance and mass surrender risk have been analyzed by Milhaud *et al.* (2010), Loisel and Milhaud (2011) and in numerous actuarial dissertations. Loisel and Milhaud (2011) consider copycat behavior risk analogous to the one observed in bank runs (Diamond and Dybvig, 1983). They also point out the example of some specialized newspapers that provide detailed information on the UK mortgage market and which were shown to have a tremendous impact on their readers, fostering prepayment under specific circumstances.

However, it must be noted that the analogy between lapses and runs is quite imperfect. First, the alternatives available to customers are different from one market to the other. Second, the insurance supervisor has more leeway to stop or delay surrenders in order to protect customers from the consequences of a mass surrender episode. Last, fiscal rules do play an important role in preventing withdrawals before eight years (even more than the prepayment penalties in the banking industry). Dutang *et al.* (2013) study competition between non-life insurers, insurers' strategies and policyholders' lapse decisions using non-cooperative game theory. It would be interesting to carry out a similar analysis on the savings market, but due to the currently available data, we leave it for further research and we only use the concept of policyholders' expected participation rate.

Note that surrender rates are not the only behavioral variables of interest. For tax reasons, policyholders may not want to surrender their contracts. For instance, the older a life-insurance contract, the less taxed the interests, with the lowest tax rate reached for contracts older than 8 years. Yet, those unhappy with the participation rates they are offered can still choose to reduce or stop future payments, which affects the insurer's collection rate. Note that for old contracts with high guaranteed rates, the insurer is penalized if surrender rates are too low. For those (often closed) contracts, the insurer has deliberate decollection objectives, with little levers (reduction of profit-sharing to the minimum). *A contrario*, for currently sold contracts, insurers often have ambitious collection objectives and offer generous rates to attract new clients. Gandolphe (2014) underpins the dispersion of participation rates offered by the same insurer for different contract perimeters. Because our data-set is not granular enough, we can only capture the aggregated impact of this heterogeneity for each insurer using fixed effects.

2.4 Competition in insurance and risk neutral valuation

Competition between insurers is studied by Dutang *et al.* (2013) in the property and casualty market (P&C), but is very seldom addressed in the participation strategy literature, except indirectly through target rates which correspond to what needs to be reached to stay in the market. We leave a more in-depth treatment of competition aspects for future research, as this requires additional data.

Note also that Bacinello (2001), Ballotta *et al.* (2006), Kemp (2011) and most previously cited authors use a risk neutral valuation framework. The relevance of this choice (made so often for fair value, Market-Consistent Embedded Value and some Solvency II computations) is questioned in insurance and is often inappropriate for decision making and optimization (see Kemp, 2009; Vedani *et al.*, 2014), but this matter is not discussed in this paper.

We have seen so far that average interest rate levels, insurers' asset performance, stability reserve levels as well as policyholders' expectations and behaviors are often said to explain participation strategies in some stylized frameworks that imperfectly reproduce the complexity of the French savings market. We shall now present the data used for the study and the relevant variables associated with these concepts.

3 French regulatory framework

3.1 Reserves

There are two types of legal reserves that can impact the financial returns used to determinate the legally binding minimum amount of profit sharing.

The *Provision pour participation aux bénéfices* (PPB – the French **profit sharing reserve**). The relationship between the PPB and the participation rate is fairly mechanical since the PPB is depleted in order to increase the participation rate and *vice versa*, following the ideas of Grosen and Løchte Jørgensen (2000). One needs to keep in mind that the primary goal of the PPB is to smooth the variations of the participation rate. It thus acts as a buffer stock, and its variations should theoretically be uncorrelated with the variable it smooths. However, the stock gives a good indication of the insurer's ability to face bad years.

Asset reserves. We regard three distinct legal reserves on assets: the *provision pour risque d'éligibilité* (PRE), the *provision pour dépréciation durable* (PDD) and the *réserve de capitalisation* (RC) as they can be used to pilot the aggregate financial results, which in turn are at the root of the calculation of the minimum legal profit sharing amount. The PRE is an overall provision that is endowed when the amount of unrealized capital losses over the entire portfolio exceeds a given threshold. The mechanism is identical for the PDD, but at the individual asset level. The *réserve de capitalisation* stores the capital gains made on the various bonds. All three reserves have an effect on the accounting rate of return of the asset portfolio which is used to determine the legal amount of profit sharing.

3.2 Tax regime

It would have been extremely interesting to account for the evolution in the taxation regime of life insurance in France. Indeed, over the past 35 years, the fiscal advantages of this type of placements eroded substantially. However, most of the time, the major fiscal changes took place before the beginning of the period under survey i.e. 1999. For instance, the *Contributions sociales*[4] on the accrued interests came up from 0% before 1996 to 15.5% in 2014, but the largest part of the increase occurred between 1996 and 1998, when the rate was already 10%. Similarly, since 1983, contracts that were more than 6 years old were benefiting from a full income tax exemption. Yet in 1990 this exemption was only granted after 8 years, and in 1998, the full exemption became a reduced taxation at a rate of 7.5%. Since then, the tax brackets did not change. Consequently, with our database covering the period 1999-2013, we are not able to assess the impact of these major fiscal changes.

3.3 Contracts and their specificities

In France, the two main types of life-insurance products are euro-denominated and unit-linked contracts. In our investigation, we focused on individual euro-denominated contracts. The purpose of this section is to provide briefly the main structure and characteristics of this category of contracts on the French market.

Euro-denominated contracts in their purest form are savings products with guaranteed capital. The amount of money collected by the insurer is invested on the financial markets, and the French law imposes that at least 85% of the financial results and 90% of the technical results be redistributed to policyholders (article A.331-4 of the *Code des Assurances*). This is the legal profit-sharing mechanism (participation aux bénéfices), which applies at the fund level. However, it is important to understand that much leeway is given to the insurer with respect to the timing of the legal profit distribution: it can either be distributed immediately (more precisely at the end of the year during which the benefits were realized), or stored in a smoothing reserve (*Provision pour participation aux bénéfices*, PPB), with the obligation to distribute it within eight years (article A.132-7).

The mathematical provisions are computed using a technical interest rate (*taux technique*)

[4]These *Contribution sociales* encompass several direct proportional taxes earmarked to fund the social security system. The largest and oldest is the CSG or *Contribution sociale généralisée* which was established in 1990 and did not apply to the life insurance interests before 1997.

which is bounded by the *Code des Assurances* (article A.132-1) to a maximum of 75% of the semi-annual average of the French sovereign bonds at the date of subscription for the first eight years, and a maximum of 60% of this very rate afterwards[5]. The interests paid to the policyholders cannot be less than this technical rate, which can therefore be considered as a guaranteed rate of return. Over the past decade, in a context of decreasing yields, most contracts were set with a 0 technical rate. This guarantee thus turned redundant with the capital guarantee (but old contracts still in portfolio remain a matter of concern).

On top of this regulatory minimum, the insurer can offer to guarantee contractually[6] a given level of profit-sharing (*taux minimum garanti*) as a commercial argument (article A.132-2 and A.132-3). Until the *Arrêté du* 7 *juillet* 2010, the Code read that these minimal guaranteed rates could be fixed for several years, or revised annually, with an upper bound equal to 85%[7] of the insurer's average return on assets over the previous two years. The guarantee could also vary according to a financial reference, but for no more than eight years. Since 2010, the guaranteed rates can only be offered on an **annual** basis (*Taux minimum annuel garanti*) and are limited to 80% of the insurer's average return on assets over the previous two years. Other limitations were included in 2010, with references to the maximal technical rate and the average rate served to the policyholders over the previous two years.

In the end, it may seem that the rates served to the policyholders are fairly constrained, with minimal profit-participation to be given, and multiple limitations in terms of the guarantees that can be provided. However, the inter-temporal smoothing through the PPB and the legislative limitations to the guarantees offered to the policyholders makes the profit-sharing mechanism extremely discretionary on the French market.

It is essential to understand that the minimal profit-sharing rules are in no way applied on a contract by contract basis. In addition to the discretionary timing of the distribution, there is indeed much leeway in the allocation of the profit participation across the policies in the portfolio. Some groups of contracts can be particularly favored (as they include profit-sharing clauses, for instance), while others might receive extremely limited participation (for instance, because the policyholders are deemed very unlikely to lapse). These features could not be captured with the prudential data we used as they were not granular enough, but further analyses should definitely try to address the issue of fairness in the distribution of the amounts of profit-sharing over the contracts.

[5]Note that we indicated the current binding constraint, but the *Code des Assurances* stipulates that after eight years, the technical rate is also subject to an upper limit of 3.5%. These limits were set in their current form in 1995

[6]Other contractual mechanisms exist (e.g. promotional rates) but the *taux minimum garanti* is clearly the most common.

[7]Before 1995, this limit was 90% [*Arrêté du* 28 *mars* 1995*, JORF n°*83 *du* 7 *avril* 1995*, entrée en application au* 1*er juin* 1995]

4 Data and explanatory variables

The data used in this paper comes from the ACPR, the French authority in charge of insurance supervision. In this section, we explain the different steps taken to build the database, we describe our variables of interest, and we provide a first graphical analysis of the data.

4.1 Data

This paper is based on a new data set that we build from the regulatory data reported by each French insurance undertaking[8] to the French supervisor on an annual basis[9]. This regulatory database mainly contains aggregated accounting data and prudential information gathered for the purpose of the permanent monitoring of the French insurance market. It is used to ensure compliance with the law and to check the undertakings' solvency positions under the Solvency I framework.

We use this source to construct indicators at the entity level, since more granular primary data is not available. We consider only the undertakings' branches that correspond to individual savings contracts with profit participation. Technically speaking, we consider contracts classified in categories 1 (*Contrats de capitalisation à prime unique*), 2 (*Contrats de capitalisation à prime périodique*), 4 (*Autres contrats individuels d'assurance vie à prime unique*) and 5 (*Autres contrats individuels d'assurance vie à prime périodique*) according to article A.344-2 of the *Code des Assurances*. In practice, category 4 is clearly the most important in terms of mathematical reserves and drives the results. The source of data, its limitations, and the procedure used to build the variables of interest are precisely described in Appendix 1. Table 1 presents the number of observed insurance undertakings during the period and the corresponding total amount of mathematical reserves at the end of the year.

[Table 1 about here.]

To this day, and after cleaning the data, we have a sample of 89 entities over a period of 15 years (1999 to 2013). Due to missing data and mergers, we actually observe between 51 and 71 undertakings each year, and the total number of observations ($individual \times year$)

[8] The expression "insurance undertaking" should be understood in its broadest sense, as it includes all the undertakings in the insurance sector that are under ACPR supervision. For the life insurance market, there exist three main French insurance legislation regimes, namely the Insurance Code (*Code des Assurances*), the Mutual Insurance Code (*Code de la Mutualité*) and the Social Security Code (*Code de la Sécurité Sociale*), all regimes falling under ACPR supervisions.

[9] See http://acpr.banque-france.fr/documents-a-remettre-en-assurance.html for a description (in French) of the reporting templates. In short, undertakings must submit an annual report including general information, accounting documents (balance sheet, P&L ...) and data for prudential needs i.e. credit, reinsurance, solvency, reserves reports.

is 936. Note however that the set of entities we leave aside – either because of size or due to lack of proper data – only represents a small portion of the overall mathematical reserves over the period. Depending on the year, it corresponds to between 1% and 25% of the total mathematical reserves for the scope of interest.

Our data is therefore limited to the largest French life insurance undertakings (mathematical reserves larger than EUR 50 million) and this choice implies that our results are not necessary valid for excluded entities, since small companies probably have a specific behavior. Note that the final scope excludes all providence institutions (*Institutions de prévoyance*) which are ruled by the *Code de la Sécurité Sociale*.

We also wish to stress that the initial data-set is not balanced, for obvious reasons of mergers and acquisitions between firms. Obviously, the final data-set is not either. To illustrate this point, only 31 undertakings are followed over the entire 15−years period, i.e. they are fully observed over the whole period $1999-2013$, have no missing data, no atypical points and no significant mergers or acquisitions. Furthermore, we would like to point out that the sample is not very large (neither in terms of undertakings – 89 firms – nor in terms of time depth – 15 years).

4.2 Variables of interest

Our variables of interest are calculated from the entity-level information contained in the annual supervisory reports (detailed balance-sheet data, P&L data, and other specific complementary information requested by the supervisor for micro-prudential purposes). Notice that the vast majority of the insurers in our panel are not listed and we therefore cannot use market data as a supplementary source of information. To have a summary view of each entity, we consider four classes of specific variables that we expect to have effects on profit sharing policy. Table 2 lists the variables, their definition as well as their source.

[Table 2 about here.]

Participation rate: Our dependent variable, the aggregated participation rate is not a standardized raw data that can be found directly in the prudential reports. A new survey was launched by the ACPR in 2008 to collect participation rate information at a contract level, but this does not provide us with enough time depth. We therefore calculate for each undertaking and each year the mean participation rate from the accounting data.

Soundness variables. It seems natural to consider soundness variables since the more an entity is robust, the more it is flexible. We therefore consider a variable measuring the solvency position (capital ratio), for potential capital shortages; an indicator of the amount of unrealized capital gains and losses (UCGL) capturing the potential liquidity issues in case of crisis; as well as a variable relating to the amount stocked in the *Provision pour participation* *aux bénéfices* (PPB – the French profit sharing reserve). The relationship between the PPB and the participation rate is fairly mechanical since the PPB is depleted in order to increase the participation rate and *vice versa*, following the ideas of Grosen and Løchte Jørgensen (2000). One needs to keep in mind that the primary goal of the PPB is to smooth the variations of the participation rate. It thus acts as a buffer stock, and its variations should theoretically be uncorrelated with the variable it smooths. However, the stock gives a good indication of the insurer's ability to face bad years.

Size variables. The accounting data from the P&L allows to easily measure the size of an insurer. For that purpose, we consider the amount of mathematical reserves (log). The size of an insurer theoretically allows it to benefit from greater risk diversification and to have more leeway in the management of its fees.

ALM variables. The main source of income for a life insurer lies in its asset returns. In a mechanical way, it seems reasonable to assume that the financial products a firms manages to accumulate a given year will be correlated to the participation rates that it will be able to distribute. Indeed, by definition, the participation policy aims at distributing the profits generated over the year: the more profitable the assets, the higher the benefits to be distributed. This rationale is similar to that introduced by Bacinello (2001). Furthermore, an interesting component of the asset returns is the amount of capital gains as an evidence of management rules for boosting incomes. Third, we analyze the share of assets invested in equity as an indicator of the risk taken by the insurer. Eventually, we also consider the financial margin as the financial products generated by the company can either be stocked in the PPB for future use, or distributed to the policyholders *via* the participation rate, or be included in the company's financial results (with potential distribution to the shareholders), in analogy with the optimal dividend strategies surveyed in Avanzi (2009).

Policyholder' behavior. The participation rate is a key management instrument to contain lapses. Of course, all lapses are not detrimental to an insurer: on some old contracts with high guaranteed rates, insurers deliberately try to incentivize their clients to surrender. Yet in general, lapse is not a good thing and it often reflects a lack of competitiveness or a widespread distrust of the insurer. One way to limit lapses is therefore, when possible, to serve high participation rates (or at least rates that are in line with the market or the potential other substitutes). At the individual level, it is important to be aware that the causality between lapse and participation can go either way: an insurer may want to increase its participation rate to limit the surrenders, but it can also face a high lapse rate because he did not provide a sufficient participation rate. Following Milhaud *et al.* (2011), one would therefore expect that participation and lapse rate would move in the opposite direction: the higher the participation rate, the lower the incentive to surrender in a given year.

Environmental variables. Aside from the supervisory data, we also want to include variables that capture the general evolution of the financial and macroeconomic contexts. Obviously, these variables are common to all undertakings, and thus materialize a natural drift for the panel analysis. Moreover, given that the study is limited to 15 years, we cannot get a good picture of an entire business cycle. Last, since we only have 15 observations for each macroeconomic variable, it would not be significant to use more than one of them into our regression. Following Planchet and Thérond (2007) and Gandolphe (2014), we expect the OAT rate to have a great impact on the participation rate, and we thus consider in priority the 10-years OAT rate as the main indicator for both the temporal drift and the macroeconomic context. Other economic and financial covariates such as the annual return on the CAC40, the annual realized volatility on the CAC40 index, the French GDP growth, the French IPC growth and the French unemployment rate change were initially considered but have been rejected for lack of significance compared to the French government bonds rates.

Some descriptive analysis and graphical evidence of the main potential drivers of the observable trend are displayed below. This graphical depiction is motivated by the lack of empirical studies on profit sharing strategies in France, and the large differences with the other European systems. It enables us to examine some insights from practitioners. In Figure 1, we display the evolution of the participation rate and the asset returns and confront it with the OAT rates.

[Figure 1 about here.]

We notice that the mean and median participation rate are characterized by a smooth downward trend. They seem to follow the French "safe" asset with a lag of some years. This is particularly visible when the government bond rate breaks its trend, as is the case in 2005 for instance. If we observe the distribution of the participation rates over the period, we note a low variability around the median indicating a high degree of market concentration. Hence, our aim is to understand how the government bond rates cycles could drive the insurer's profit sharing policy as the series seem follow parallel trends. Several interpretations of this fact can be proposed. The first one is that insurers use the 10-year government bond as a short term target, and consider that, given the duration of their liabilities[10], they should serve about the same yield. The second explanation is that the OAT-10 actually captures the general macroeconomic environment, which affects the asset returns, which in turn affect the profits to be shared with policyholders.

On the asset side, we can see that the average and the median of these returns are both higher that the OAT rates, except for year 2002. From this Figure 1b, we deduce than the asset mix of the insurers allows them to smooth their results when the government bond rates decrease as this was the case over the period 2008-2013. For instance, this can explain the stabilization in the downward drift of the participation rates during years 2012-2013. For this variable, the causality relationship seems pretty straightforward, as it is hard to consider that the participation rate, decided at the end of the year, would have an impact on the financial products accumulated over the year.

Forgetting about the trends, if the PPB perfectly played its role, it should vary widely in order to keep the participation rate constant, and indeed, we observe in Figure 1c that

[10]This duration is largely driven by the fiscal advantage to policyholders after eight years

the amount of PPB decreases when financial stresses occur in 2001, 2008 and 2011 which is in line with a dampener instrument hypothesis.

Strikingly, Figure 1d reveals that the average and median financial margins are constant over the period with a small downward adjustment in 2009. Figure 1e plots the distribution of lapse rates over time for our sample of insurers. The average lapse rate is included in the interval $[5\%, 7\%]$ over the period and we observe upward variation in 2006-2008 and in 2011-2012. However, a direct link with the participation rate is difficult to observe at aggregated level. The rises in lapse rates do not seem to be strongly correlated with participation rates and one can even spot years in which a good participation rate (relative to the OAT) is associated with a high lapse rate. Lapse is definitely a tricky phenomena that also depends on fiscal constraints the effects of which are difficult to capture.

Finally, this rough analysis provides some insights about the main drivers of the participation strategy which we will test in the next subsections with a deeper econometric analysis.

5 Empirical strategy

In this section, we introduce our empirical strategy. First, we expose formally our methods, with on the one hand a series of static models built around the OAT rate and on the other hand a couple of dynamic models with lagged participation rates.

5.1 The baseline model

Our aim is to look at the evolution of the participation rate and, as already mentioned, the literature dedicated to this issue is scarce. Profit sharing policy is quite complex to model as insurers develop multi-criteria strategies across time (Hainaut, 2009). It is clear that various types of strategies can emerge but it seems reasonable to consider that insurers aim at maximizing their future profits over a specific time-horizon, under solvency and regulatory constraints. Life insurers can use the PPB reserves to smooth future incomes and are encouraged to keep the more profitable contracts within the portfolio (i.e. avoid their surrender). Thus, in a very stylized way, it seems reasonable to consider that insurers may want to reach a target participation rate as an aggregated control variable. Since the French life insurance market is characterized by low guaranteed rates, the only way for an insurer to control lapses is to serve competitive participation rates. A similar specification has been recently proposed by Bonnin *et al.* (2014) in a stylized model for saving contracts, as part of the ORSA[11] This target can be reached either with financial income (fixed incomes or capital gains) or through adjustments in the level of PPB. Notice that, in good times, there exists

[11]The *Own Risk Solvency Assessment* under the Solvency II framework. See also Guibert *et al.* (2014).

a trade-off between raising the contracts' participation rates immediately, and endowing the PPB to release it in the bad years that could follow.

To account for this, we specified a baseline model with a latent target participation rate. This latent rate aims at satisfying policyholders' expectations in order to avoid the negative consequences of an increase in surrenders. For a given time t, we assume that the participation rate follows the OAT-10Y plus a target rate spread, and deviation from this target depends on specific variables. As this target is not observable, we try to approximate it using the previous analysis and the specifications used by practitioners for valuation purposes. Let $r_{i,t}$ be the participation rate at the end of year t for insurer i, $\rho_{i,t} = r_{i,t} - r_t^{OAT}$ our variable of interest that we call the participation rate spread over the OAT-10Y rate, r_t^{OAT}, and $\rho_{i,t}^*$ the specific targeted rate spread of insurer i. We introduce the baseline linear model to assess the participation rate spread

$$\rho_{i,t} = \alpha \rho_{i,t}^* + \boldsymbol{\beta}^\top \boldsymbol{x}_{i,t} + \mu_i + \varepsilon_{i,t} \ , \tag{5.1}$$

where $\boldsymbol{x}_{i,t}$ represents a vector of specific control variables which can be either known at time $t-1$ or observed during year t. μ_i corresponds to the insurer fixed effect and $\varepsilon_{i,t}$ a random disturbance term of mean 0.

Our intuition is that insurers aim to be as close as possible to their target and the actual deviation is merely explained by unexpected change in specific indicators. For consistency reasons, we also consider the return on assets relative to the 10-years French government bond. This variable change (choosing not to explain the absolute value of the participation rate, but rather its departure from the current OAT-10Y rate r_t^{OAT}), enables us to somewhat de-trend our data in a way that is natural to asset managers in the insurance industry, knowing the implicit benchmark role of the OAT. Yet, we also include in our regressions the absolute rate of the OAT-10Y as a control variable to make sure we account for the evolution of the macroeconomic context, and to anchor our model in absolute terms. Other observable covariates, that could be potential drivers of participation, were described in Subsection 4.2.

As the target rate references used by practitioners are really close to and highly correlated with the OAT-10Y rate, we first assume a common target rate spread equal to 0, i.e. $\rho_{i,t}^* = 0$. The model we eventually estimate can thus be written

$$\rho_{i,t} = \widetilde{\boldsymbol{\beta}}^\top \boldsymbol{x}_{i,t} + \mu_i + \varepsilon_{i,t}, \tag{5.2}$$

where the vector $\boldsymbol{x}_{i,t}$ contains the OAT rate.

We consider different sets of explanatory variables and test both pooled OLS and insurer fixed-effect estimators[12].

[12] See e.g. Baltagi (2013) for description of classic techniques used for panel data.

5.2 Dynamic model

In the previous subsection, we assume that the target rate spread is common, and that the level of the participation rate only depends on the OAT 10Y rate. We now want to test a more flexible model where the target at time t depends also on the observed rate spread at time $t-1$. With this specification, our rationale is that policyholders expect that participation rates are smooth over time and consider the previous rate as an implicit reference. With this assumption, the participation rate at time t depends on the participation rate at time $t-1$. Then, Equation (5.1) takes the form

$$\rho_{i,t} = \gamma \rho_{i,t-1} + \boldsymbol{\delta}^\top \boldsymbol{x}_{i,t} + \mu_i + \varepsilon_{i,t}. \tag{5.3}$$

The model defined by Equation (5.3) is a dynamic panel model, which breeds some questions about the estimation procedure. As noted by Bond (2002), for dynamic models, the OLS estimator is biased upwards while the fixed effects estimator is biased downwards. A suitable technique with dynamic panel data consists in using a generalized method of moments(GMM) estimator based on the fact that the number of valid instruments is growing with t. This framework is widely used by macro-economists but poses many problems for micro-economists[13] and this approach is therefore also questionable for our data-set. Judson and Owen (1999) explain that the bias induced by a classic GMM method for short unbalanced panel data is likely to be important. In this particular context, they would recommend a one-step GMM estimator. However, our data-set is largely unbalanced with $T = 15$ and $N = 89$ and the gain provided by this technique does not seem crucial. A correct use of GMM methods requires a thorough discussion of all the specification choices (number of instrumental variables, Difference versus System GMM, suitable robust variance estimators...) which is relatively tricky. Thus, we decide at this stage for the sake of simplicity to run OLS and fixed effect estimations of our dynamic panel model in order to provide a reliable interval for the γ coefficient while being well aware of the limitations of this approach.

6 Empirical results

In this section, we present the main results obtained[14]. The first subsection focuses on the results obtained with a static target rate. The second one analyzes the econometric results of the more advanced model with a dynamic target rate.

[13] See e.g. Duprey and Lé (2014) for recent application to bank capital adjustment dynamic.
[14] Computations were carried out with `Stata`.

6.1 Econometric analysis with static target rate

In Table 3, we display the estimations of the baseline model from Equation 5.2 both with OLS and Fixed effects specifications and with the major potential explanatory variables of the spread between the participation rates and the OAT rate (added one at a time).

[Table 3 about here.]

For each model specification, the first column corresponds to the pooled OLS regression, and the second one to the model with fixed effects. The idea is to see whether we could capture some of the content of the fixed effects, and whether the coefficients of the baseline model would be affected by the introduction of these additional variables. The estimations appear to be relatively stable in terms of sign and significance.

The impact of asset's performance on participation is positive, yet moderate in terms of magnitude, as a return on assets one percentage point (100*bps*) higher than the OAT implies a participation rate only 10 to 20*bps* above the French govies. Of course, this relates to the regularity objective as good performances are surely partially stored in the PPB reserve for future release. Nevertheless, one can question the low level of pass-through for the financial performances.

The OAT-10Y and the average participation spread move in the opposite direction. This relationship is largely significant, and can be interpreted as a smaller leeway to distribute below the OAT when the OAT is itself closer to zero. We then add the lapse rate, which consistently comes out as negatively and statistically significantly correlated with the participation spread (even under different specifications). This coefficient is *prima facia* counter-intuitive: it seems to indicate that a higher occurrence of lapses for a given firm over the year be associated, end of year, with a smaller departure of the participation from the OAT. In other words, more lapses would lower participation. We had hypothesized that insurance executives would have tried to contain the increase in lapses through a higher participation rate, but this appears not to be the case. As we already mentioned, the link between participation and lapse is not straightforward. This result might mean that insurers are not so concerned by lapses, but more probably, it might indicate that they manage lapses at a more granular level than the one we can observe with our data. They indeed have the possibility to increase the participation on contracts they really want to keep in their portfolio while lowering the average participation they serve in aggregate. Another explanation would be that lapses and participation are both linked to the general macroeconomic context, which, when deteriorating, induces simultaneously more lapses (emergency funds theory) and lower financial results on the insurers' assets and thus lower participation.

Last, for the baseline model, we consider the level of the profit participation reserve at the beginning of the period. This variable is positively and significantly correlated with the participation spread under the fixed effects specification. This confirms that a higher stock of PPB enables the insurer to serve higher rates. Good past performances help boost participation. Yet the magnitude is extremely small, as a level of PPB relative to Mathematical Reserves one percentage point higher is only associated with six additional bps on the participation.

Building on this parsimonious model (Model 4), we try to add other potential explanatory candidates, in order to see whether they can explain part of the remaining variance (and check the stability of our coefficients to the introduction of these variables).

We decide to first look at the **soundness variables** (Models 5.a and 5.b) and the **size variable** (Model 6). The results of the estimations are presented in Table 4.

[Table 4 about here.]

The coefficients on the reference model's variables do not change much with the introduction of the additional terms, except for the one on asset returns, which is reduced by an amount equivalent to the value of the coefficient on the newly introduced UCGL variable. We therefore merely decompose part of the variance previously attributed to the financial performances.

Due to missing data, our sample is marginally reduced with the solvency ratio variable, yet the coefficients of the baseline model are stable. The coverage ratio is significant at the 10 % level in the FE specification, yet the impact is extremely small.

The size variable (the natural logarithm of the mathematical reserves) does not alter the baseline model coefficient. The variable itself is only significant under the pooled-OLS specification, as there is not much variation for a given individual across time. The coefficient is positive, yet extremely small as it indicates that an increase in the MRs by 1 % is associated with a increase in the participation by $5bps$.

Second, we study the effect of the introduction of several **reserving variables** (the *Provision pour risque d'exigibilité* – PRE, the *Provision pour dépréciation durable* – PDD and the *Réserve de capitalisation* – RC) on our reference model (Model 4).

[Table 5 about here.]

The results reported in Table 5 indicate clearly that PRE and PDD have no effect on the regression, whereas the RC comes out as statistically significantly correlated with the participation rate under the FE specification. The order of magnitude of the coefficient is small, about the same as the one on the PPB. The coefficients of the baseline model are not affected by the new variable.

In a last step, we consider two **ALM variables** in addition to the asset return variable: the asset structure (Model 8.a), and the capital gain ratio (Model 8.b) (Table 6).

[Table 6 about here.]

The coefficient before the share of equity comes out as significant under both OLS and FE specifications. It is negative, meaning that more investment in equity implies generally a lower participation. This can be rather surprising, as one would expect that more risk should be associated with higher yields over the long term. Note however that the magnitude is small. The coefficients of the baseline model are not much affected by the introduction of this asset allocation variable, except, unsurprisingly and only marginally the one for the return variable. The capital gains ratio has no significant impact on the model.

In a nutshell, our Model 4 seems fairly robust to the introduction of additional variables (limited omitted variable bias), and might be usefully complemented with the UCGL, RC, and asset structure variables (note however that these variables do not add much explanatory power to the model).

We would like to emphasize here that the definition of the covariates greatly limits the potentiality for reverse causality. Indeed, the participation rate is decided at the end of year. The annual financial performances, the average OAT-rate over the year, and the lapses are thus perfectly known at the time of decision. Additionally, we considered the PPB stock at the beginning of the year to avoid the potential endogeneity that stems from the trade-off, at the end of the year, between distributing the financial results and endowing the PPB. The four explanatory variables are thus perfectly exogenous to the participation rate. This does not precludes the possibility that some variables could be driven by another latent factor, yet the OAT variable seems to fairly well capture the general effect of the macroeconomic environment.

6.2 Econometric analysis with dynamic target rate

We propose an alternative model to take into account the auto-correlation feature of the participation rate. In Table 7, we present the results of this dynamic model.

[Table 7 about here.]

Unsurprisingly, the lagged participation rate comes out positive and statistically significant in every specification , although the magnitude of the coefficient is eroded as we add more control variables. The coefficients on the common covariates of Model 4 and Model 12 are extremely close. This alternative specification preserves the signs, magnitude and significance of the estimated parameters.

6.3 Robustness checks

In order to check the consistency of our estimates, we decided to run the model over two sub-periods of 7 years to assess the time stability of the coefficients (note that 2006 belongs to the two sub-periods). The results are fairly encouraging as the point estimates are rather stable across the different sub-periods.

[Table 8 about here.]

Indeed, as can be seen in Table 8, in both the OLS and fixed-effects specifications with static target rate, the signs and orders of magnitude are preserved from one sub-period to the other. More precisely, it appears that the coefficient on the financial performance relative to the French government bond stays positive and statistically significant, yet decreases in magnitude from one sub-period to the other (from 0.11 to 0.06). Good financial performances seem to translate less and less into better participation rates. The coefficient on the OAT remains negative and large. The continuous decrease of the government bonds rates over the period could explain the slight increase in the absolute value of the coefficient, as it becomes more complicated to serve less than the OAT while staying above the legal 0 bound. As the OAT gets close to zero, the mean of participation spread can only increase. The coefficient for the lapse rate remains negative and statistically significant, although almost halved in absolute value. The coefficient on the stock of PPB turns consistently around 0.8.

We extracted the content of the fixed-effects to see whether they were coherent from one period to the other. A simple OLS regression of the coefficients for the first period on the coefficients for the second yields a point estimate of 0.97 significant at the 1% confidence level and a R^2 of .52: this tends to confirm that the fixed effects do capture idiosyncratic characteristics which are stable over time.

These robustness checks seem to confirm the main findings of the paper concerning the static model. We obtain similar results with the dynamic model.

6.4 Clustering of insurers

As we observe the individual data, several participation patterns seem to emerge. Of course, with only at most 15 years at hand, we cannot be certain that what we can see is a firm line of conduct for the considered undertaking: for many companies, we do not have enough variability to extrapolate an implicit behavioral rule, yet for some, it becomes clear that a constant financial margin is targeted, with priority over a smooth participation rate. For others, with a more "mutual insurance" type, the bad financial performances are absorbed through a lower financial margin, and the participation rates are maintained close to the OAT. The definition of "standard patterns" is a natural next step for our analysis, but the small average number of observations per company makes the categorization difficult or very dependent on an expert's classification.

For the moment, we choose to consider a simple grouping of the companies according to their average financial performance over the period of observation. The idea is to pinpoint those companies which were consistently showing poor assets' returns, and see whether their behaviors were significantly different from the rest. In line with our previous approach, we consider that poor performances can be characterized by a return on assets lower than the OAT-10Y. We consider a statistic corresponding to the average spread between the assets' returns and the OAT over the period $\bar{\rho}_i$, corrected by the standard deviation σ_i^ρ. Yet, as already mentioned, the number of observations per companies is small and varies from one firm to the other. We therefore need to correct the standard error, and divide it by the square root of the number of observations N_i. In the end, the indicator we use to order the companies according to their financial performances is Γ_i:

$$\Gamma_i = \bar{\rho}_i - \frac{\sigma_i^\rho}{\sqrt{N_i}}$$

We group the firms into four categories:

- In category ***A***, we gather all companies for which the statistic Γ is below zero (19 insurers and 160 observations). Broadly speaking, those are the firms which, over the period of observation, have performed below the OAT.
- Category ***B*** encompasses the companies with a Γ between 0 and 0.5 (28 undertakings for 285 observations)
- The insurers in category ***C*** have a Γ between 0.5 and 1 (22 companies and 252 observations);
- Category ***D*** corresponds to the out-performers, with a Γ larger than 1 (20 firms and 239 observations). Leaving aside the correcting factor, this means that these companies outperformed the OAT by more than 100*bps* on average over the period of observation.

The thresholds were set arbitrarily (except for the zero bound), but it appears that the four groups are rather balanced and enable us to conduct estimations on the sub-samples.

[Table 9 about here.]

We first look at descriptive statistics, as we want to see whether the performances on the financial markets translated into heterogeneous participation strategies. A simple regression on the group dummies gives a very interesting result (see Table 9). The average participation for the reference category (***B***) is negative (-0.001) and statistically significantly different from zero. It also appears that group $\boldsymbol{C}$ is not statistically different from group $\boldsymbol{B}$. The sample of 50 insurers resulting from the merge of $\boldsymbol{B}$ and $\boldsymbol{C}$ made on average between 0 and 100*bps* more than the OAT with their assets (82*bps* on aggregate). Yet, they gave on average 10 to 20*bps* **less** than the OAT to their policyholders.

The other two groups ($\boldsymbol{A}$ and $\boldsymbol{D}$) differ significantly: on average, the poor performers, whose aggregated mean performance was 65*bps* below the OAT served a participation 50*bps* below the OAT. On average, then, those undertakings gave more to their policyholders than they made on the markets.

As for the out-performers, whose aggregated average performance was 160*bps* above the OAT over the period, they served just below the OAT rate to their policyholders. This is particularly questioning, as the legal framework is not meant to allow for such a disconnect between financial performances and profit-sharing, and even accounting for the option to differ the participation through the PPB, this disconnect should not appear on a 15 years period, given the obligation to release the PPB within 8 years.

Second, we estimate Model 4 for each sub-group. The results of these estimations are displayed in Table 10.

[Table 10 about here.]

Although the signs and significance levels are broadly preserved, it clearly appears that the magnitude of the coefficients varies across categories. Indeed (and this is fairly natural), the more performing an insurer, the less important the OAT in the determination of the participation rate. Yet, more surprisingly, the performance itself becomes less relevant. Another interesting result concerns the lapse rates, which become insignificant for the poor performers.

7 Conclusion

In this paper, we aim at better understanding the main drivers of the participation strategy in the French life insurance market. We build a new data-set from confidential regulatory data at the firm level. Our econometric analyses show that the average participation rate is largely determined by the government bond rate as well as by the firm's asset return, and is correlated with the lapse rate. Other variables are relevant (in particular le level of PPB). To the best of our knowledge, we are the first to provide empirical evidence of these phenomena.

In France, profit sharing depends essentially on contract clauses and most contracts are associated with a 0% minimum guaranteed rate. The minimum level of guaranteed return for life contracts is not set by the law (contrary to what can be seen in other European countries[15]) but is bounded by the regulatory framework. However, even with such enforcement rules the French framework would not necessary guarantee an even profit sharing level among policyholder groups. Indeed, the PPB can be used by insurers to pilot the participation rate, and ensuring that it the actually released within 8 years (as required by the law) can be very tricky for insurance supervisors. It is also extremely complicated to ensure that the different types of contractors are actually granted their share of the regulatory participation reserve. A contract by contract analysis should be done with this respect and is not covered by our analysis.

Digging further, we are able to distinguish different types of entities according to their objectives. Indeed, a graphical analysis and some simple rule of thumb classifications indicate the existence of distinct participation strategies. Some undertakings appear to smooth their financial margin while others smooth the rate they serve to policyholders, and some distribute all out-performances but never serve less than the government bonds (i.e. they absorb the bad performances. Firms also differ in their use of the PPB: some manage it very actively while others do not. This typology could be used by supervisors for spotting potential misbehavior in the effective profit sharing process.

With greater data granularity, some interesting and difficult questions could be tackled. Causality between lapses and participation rates could not be tested with our data-set, but this is an extremely relevant question, especially under the Solvency II regime. Further, the competitive aspects of the management of the participation rate appear to be crucial: some additional information on the pacing of the announcements by the undertakings could help enhance this analysis.

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[15] e.g. Germany, Austria, etc.

Appendix 1 Panel selection and treatment of outliers

To the best of our knowledge, we are the first to build such a database for the French life insurance business. Unfortunately, the data we collected was not rigorously maintained for some perimeters and we have chosen to keep only the most reliable. Indeed, we observe a lot of mistakes or contradictory information that we are not able to correct as we identified no other source of data to conduct a cross-validation. The low quality issue concerns mainly small life insurers, mutual insurances and providence institutions which we therefore remove from our sample. Notice however that the last two categories sell few saving contracts. The data for medium and big insurers is clearly of a better quality. Another issue concerns the limited time depth, as we do not have access to reliable data prior to 1999. In such a context, the main purpose of this appendix consists in checking the reliability of the supervisory data-set and justifying the selected perimeter. We summarize below the treatments and filters we applied to the data.

At first, we extracted all relevant information from the regulatory databases, selecting all undertakings with mathematical reserves larger than EUR 50 million for at least 5 years. We then scrutinized the data-set in order to identify atypical observations, correct those that were obvious reporting mistakes from the undertakings and eliminate the extreme outliers for which we could find no explanation based on our expert opinion. Indeed, we analyzed specifically each undertaking and tried to explain their unusual data points by looking in the archives for known changes in management actions or major absorption operations. Most outlying companies are small, with highly targeted customers, and experience erratic financial incomes which is probably due to the fact that they are not large enough to be able to diversify their risks efficiently.

We had to address the issue of mergers and acquisitions in our sample as these operations can induce serious changes in the financial situation of the entities they affect. These events are relatively common in the French insurance market for the period under study, and analyzing precisely their effects on the profit sharing policy is a tricky problem. We could rely on some ACPR records that documented these operations, however this information is very general and the concerned contracts and their amounts are not clearly identified. Being aware that large mergers and acquisitions can significantly bias the results, we decomposed the entities before and after the operation, and considered them as distinct undertakings. Indeed, we generally observed graphically large behavior changes for the absorbing companies in the following years.

After applying the size filters, correcting the reporting mistakes, and splitting the insurers that underwent mergers and acquisitions, we obtained a sample of 91 undertakings and 965 observations over the $1999-2013$ period. We were left with only four "pure" mutual insurers (*Mutuelles*, ruled under the *Code de la Mutualité*), corresponding to 32 observations; and no providence institution (*Institution de Prévoyance*, ruled under the *Code de la Sécurité Sociale*). Note however that one subtlety of the French legislation is that there exist so called "mutual insurers" that are ruled by the *Code des Assurances* rather than by the *Code de la*

Mutualité (the *Sociétés d'assurance mutuelle*, or mutual insurance corporations), which are often subbranches of large insurance corporations. We do have several undertakings of this type in our sample.

As could be seen with a mere histogram, the departure of the asset returns from the OAT in our dataset is concentrated between $-500bps$ and $+500bps$. Yet a few observations reach extremely high spreads. When one looks more closely at the 22 observations outside this interval, one notices that 14 (and the furthest) correspond to the same two companies. Given their atypical behavior, we decided to drop these two insurers as we suspect errors in data reported. The remaining 938 observations lie within the $[-803bps\ ;\ +748bps]$ interval.

We then looked at the distribution of the spread between the participation rate and the OAT. The histogram of this variable is much more concentrated around 0 than the return on assets variable. Indeed, most observations lie between $-300bps$ and $+300bps$ (only 12 observations were outside this interval, 5 of which, and the highest, corresponding to one of the undertaking dropped previously).

We eventually specifically scrutinized the variable coding for the stock of profit-participation reserve (PPB) relative to the mathematical reserves (MRs). This variable is considered at the beginning of year, in order to avoid endogeneity with the participation rate: indeed, the stock of PPB at the end of the year depends on the amount of profit participation distributed (at the end of the year) for the entire elapsed year. One observation indicates a negative PPB. It relates to a merger operation, and we decided to drop it. On the other hand, we note that one observation reaches 47%. When looking at the evolution of the PPB ratio for the corresponding undertaking, one clearly sees that it is a reporting mistake as the observations that precede and follow it are almost constant, around 4%. We decided to drop this observation as well.

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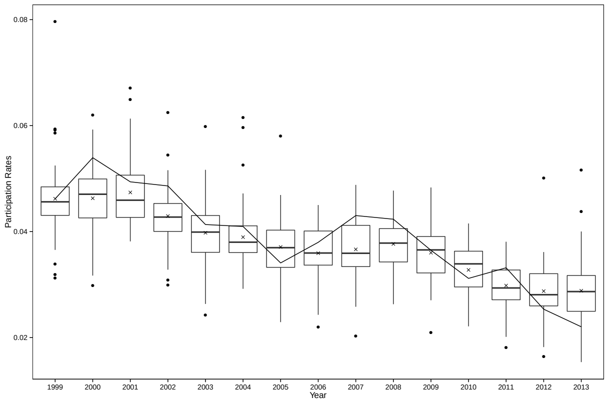
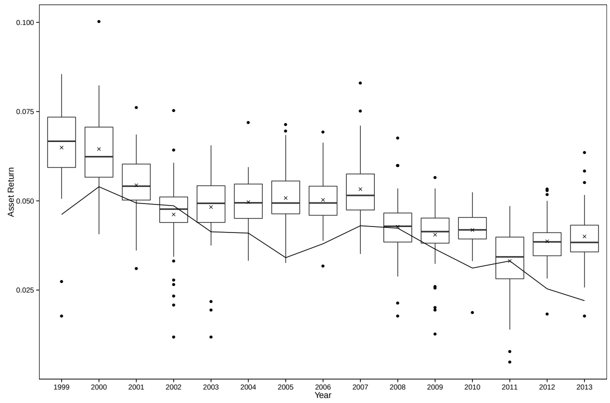
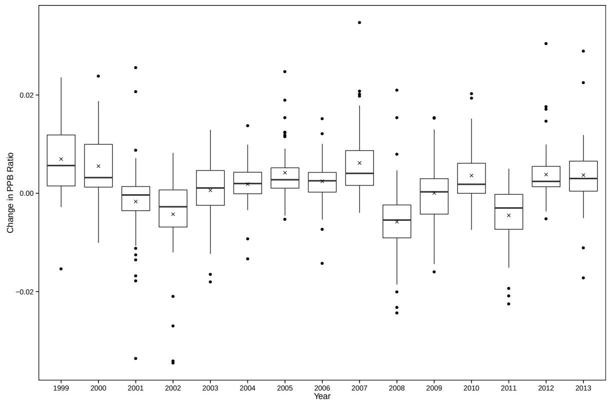


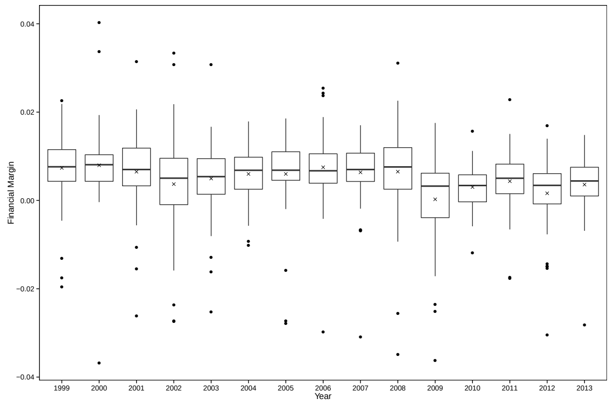
(a) Participation rates.



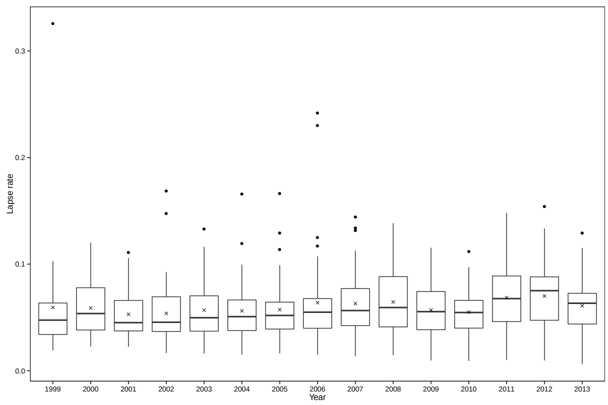
(b) Asset returns.



(c) Change in PPB ratio.



(d) Financial margin.



(e) Lapse rates.

Figure 1: Boxplots of the (a) participation rates, (b) asset returns, (c) change in PPB ratio, (d) financial margin, and (e) lapse rates over the period. The two whiskers give roughly a 95% confidence interval. The bottom and top of the box indicate the first and third quartiles, with the black band within the box representing the median, and the cross the arithmetic mean. The black line displays the OAT-10Y rates on sub-graphs (a) and (b).

Table 1: Summary statistics on the selected insurance sample.

Year	Number of insurers	Mathematical reserves	Market coverage
1999	51	286,204	75%
2000	53	316,619	78%
2001	58	372,163	81%
2002	61	407,306	81%
2003	65	490,645	90%
2004	66	591,073	94%
2005	71	653,596	94%
2006	67	712,401	95%
2007	65	712,401	87%
2008	66	844,864	96%
2009	64	906,835	96%
2010	64	993,370	97%
2011	62	1,027,407	98%
2012	64	1,056,795	99%
2013	59	1,051,076	96%

Note: This table reports the number of insurers observed for each date, the corresponding aggregated amounts of mathematical reserves (EUR million) and the market coverage (% Mathematical reserves) for categories 1, 2, 4 and 5. Mathematical reserves are indicated at the end of each year.

Table 2: Variable definitions and summary statistics.

Variable	Definition	Source	Mean	Std. Dev.
	Dependent Variable			
Participation Rate (*Taux de revalorisation*)	Sum of all technical interests and direct participation served divided by the mathematical reserves at the beginning of the year augmented by half the premium collected (to relocate mid-year), the lapses and the other outflows (net of their technical interests and participation).	French supervisory reports C1-tabs (P&L)	3.70%	0.87%
Participation Rate Spread	Departure of the firm's participation rate from the corresponding year's French government bond rate (OAT$-10Y$). A positive value means that the profit-sharing distributed exceeds the safe asset's return.	French supervisory reports C1-tabs (P&L)	$-18bps$	$77bps$
	Soundness variables			
Capital Ratio	Solvency position under Solvency I including subordinated notes.	French supervisory reports C6-tab	2.89	1.60
UCGL Ratio	Amount of unrealized capital gains and losses (UCGL), i.e. the differences between the market values and the net accounting values for all asset classes (real estate, equity, equity mutual funds, bonds, fixed-income mutual funds, loans and deposits) coming from the statement of investments, relative to the investments' net accounting value at the end of the year.	French supervisory reports Balance sheet and N3BJ-tab	5.43%	5.50%
PPB Ratio (BoY)	Amount of profit-sharing reserve (*Provision pour participation aux benefices* – PPB) divided by the mathematical reserves, both quantities taken at the beginning of the year.	French supervisory reports C1-tab (P&L)	2.48%	2.44%
	Size variable			
Log. of MRs (BoY)	Natural logarithm of the mathematical reserves (MRs) at the begin of the year.	French supervisory reports C1-tab (P&L)	7.85	1.80
	Asset reserves			
PRE Ratio	Amount of PRE (*Provision pour risque d'exigibilite*) relative to the net book value of all investments at the end of the year.	French supervisory reports C5-tab	0.14%	0.39%
PDD Ratio	Amount of PDD (*Provision pour depreciation durable*) relative to the net book value of all investments at the end of the year.	French supervisory reports N101-tab	0.70%	1.00%
RC Ratio	Amount of RC (*Reserve de capitalisation*) relative to the net book value of all investments at the end of the year.	French supervisory reports C5-tab	1.62%	1.49%
	ALM variables			
Asset Return	Ratio of the investments' net earnings, i.e. the fixed incomes plus realized capital gains and losses minus the financial management fees, in the life perimeter over the investments' total net accounting value averaged over the year.	French supervisory reports C1-tab (P&L)	4.65%	1.46%
Asset Returns Spread	Departure of the firm's asset return from the corresponding year's French government bond rate (OAT$-10Y$). A positive value means that the firm's asset portfolio outperforms the safe asset.	French supervisory reports C1-tabs (P&L)	$77bps$	$135bps$
Capital Gain Ratio	Capital gains relative to the investments' total net accounting value over the year.	French supervisory reports C1-tab (P&L)	1.36%	1.17%
Equity (perc. of Asset)	Market value of both equities and equity mutual funds at the end of the year relative to the total market value of all classes of assets.	French supervisory reports N3BJ-tab	12.7%	8.40%
Financial Margin	Investments' net earnings minus the total amount of both the net technical interest and the net distributed profit sharing and by dividing this amount by the mean mathematical reserves over the year.	French supervisory reports C1-tab (P&L)	0.49%	1.10%
	Other variables			
Lapse Rate (*Taux de rachat*)	Sum of surrender amounts divided by the the mean mathematical reserves over the year.	French supervisory reports C1-tab (P&L)	5.66%	3.02%
OAT-10Y	Yearly average of the 10-year French government bond rate (*Obligation assimilable du Tresor a 10 ans*).	Banque de France	3.88%	0.84%

Table 3: Estimating the static model.

	Participation Rate Spread $\rho_{i,t}$							
	Model 1		Model 2		Model 3		Model 4	
	OLS	FE	OLS	FE	OLS	FE	OLS	FE
Asset Return − OAT-10Y	0.205***	0.205***	0.168***	0.136***	0.194***	0.133***	0.193***	0.129***
	(0.025)	(0.027)	(0.023)	(0.023)	(0.023)	(0.022)	(0.023)	(0.022)
OAT-10Y			-0.337***	-0.365***	-0.343***	-0.389***	-0.349***	-0.421***
			(0.026)	(0.026)	(0.025)	(0.025)	(0.025)	(0.024)
Lapse Rate					-0.070***	-0.083***	-0.069***	-0.089***
					(0.007)	(0.009)	(0.007)	(0.009)
PPB Ratio (BoY)							0.011	0.063***
							(0.008)	(0.020)
Constant	-0.003***	-0.003***	0.010***	0.011***	0.014***	0.017***	0.014***	0.017***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Nobs	936	936	936	936	936	936	936	936
F statistic	66	59	118	155	121	135	91	125
R^2	0.13	0.45	0.26	0.57	0.33	0.61	0.33	0.62
Adjusted R^2	0.13	0.39	0.26	0.53	0.33	0.57	0.33	0.58

Note: This table contains the estimated parameters and their robust standard errors in parentheses (White) for the static models, with both pooled-OLS and fixed effects (FE) specifications. The constants correspond to the mean of fixed effects for FE models. *p<0.1; **p<0.05; ***p<0.01.

Table 4: Estimating the static model with impact of the soundness and size variables.

	Participation Rate Spread $\rho_{i,t}$							
	Model 4		Model 5.a		Model 5.b		Model 6	
	OLS	FE	OLS	FE	OLS	FE	OLS	FE
Asset Return − OAT-10Y	0.193***	0.129***	0.188***	0.101***	0.187***	0.121***	0.190***	0.128***
	(0.023)	(0.022)	(0.026)	(0.024)	(0.026)	(0.024)	(0.023)	(0.022)
OAT-10Y	-0.349***	-0.421***	-0.346***	-0.412***	-0.348***	-0.418***	-0.337***	-0.430***
	(0.025)	(0.024)	(0.026)	(0.024)	(0.025)	(0.025)	(0.025)	(0.027)
Lapse Rate	-0.069***	-0.089***	-0.069***	-0.088***	-0.069***	-0.089***	-0.070***	-0.089***
	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.009)
PPB Ratio (BoY)	0.011	0.063***	0.010	0.065***	0.008	0.062***	0.017**	0.063***
	(0.008)	(0.020)	(0.008)	(0.020)	(0.008)	(0.020)	(0.008)	(0.020)
UCGL Ratio			0.003	0.016***				
			(0.004)	(0.004)				
Capital Ratio					0.00024	0.00032*		
					(0.00015)	(0.00017)		
Log of the MRs							0.00047***	-0.00028
							(0.00012)	(0.00049)
Constant	0.014***	0.017***	0.014***	0.016***	0.013***	0.016***	0.010***	0.019***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)
Nobs	936	936	934	934	915	915	936	936
F statistic	91	125	78	104	79	101	76	101
R^2	0.33	0.62	0.33	0.62	0.34	0.62	0.35	0.62
Adjusted R^2	0.33	0.58	0.33	0.58	0.33	0.58	0.34	0.58

Note: This table contains the estimated parameters and their robust standard errors in parentheses (White) for the static models, with both pooled-OLS and fixed effects (FE) specifications. Models 5.*a* and 5.*b* measure the additional effect of the soundness variables and Model 6 tests the contribution of the size effects. The constant corresponds to the mean of fixed effects for FE models. *p<0.1; **p<0.05; ***p<0.01.

Table 5: Estimating the static model with impact of the asset reserves variables.

	Participation Rate Spread $\rho_{i,t}$							
	Model 4		Model 7.a		Model 7.b		Model 7.c	
	OLS	FE	OLS	FE	OLS	FE	OLS	FE
Asset Returns − OAT-10Y	0.193***	0.129***	0.193***	0.125***	0.191***	0.126***	0.191***	0.130***
	(0.023)	(0.022)	(0.025)	(0.023)	(0.024)	(0.023)	(0.023)	(0.023)
OAT-10Y	-0.349***	-0.421***	-0.349***	-0.422***	-0.352***	-0.424***,	-0.347***	-0.429***
	(0.025)	(0.024)	(0.025)	(0.024)	(0.025)	(0.024)	(0.025)	(0.024)
Lapse Rate	-0.069***	-0.089***	-0.069***	-0.088***	-0.070***	-0.089***	-0.069***	-0.089***
	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.009)
PPB Ratio (BoY)	0.011	0.063***	0.011	0.063***	0.014*	0.062***	0.010	0.062***
	(0.008)	(0.020)	(0.008)	(0.020)	(0.008)	(0.020)	(0.008)	(0.020)
PRE Ratio			-0.002	-0.056				
			(0.050)	(0.046)				
PDD Ratio					-0.024	-0.021		
					(0.021)	(0.031)		
RC Ratio							-0.007	0.090**
							(0.017)	(0.039)
Constant	0.014***	0.017***	0.014***	0.017***	0.014***	0.017***	0.014***	0.016***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Nobs	936	936	936	936	936	936	935	935
F statistic	91	125	75	100	73	103	75	106
R^2	0.33	0.62	0.33	0.62	0.34	0.62	0.33	0.62
Adjusted R^2	0.33	0.58	0.33	0.58	0.33	0.58	0.33	0.58

Note: This table contains the estimated parameters and their robust standard errors in parentheses (White) for the static models, with both pooled-OLS and fixed effects (FE) specifications. Models $7.a - c$ measure the additional effect of the asset reserves variables. The constants correspond to the mean of fixed effects for FE models. *p<0.1; **p<0.05; ***p<0.01.

Table 6: Estimating the static model with impact of the ALM variables.

	Participation Rate Spread $\rho_{i,t}$					
	Model 4		Model 8.a		Model 8.b	
	OLS	FE	OLS	FE	OLS	FE
Asset Return − OAT	0.193***	0.129***	0.198***	0.138***	0.200***	0.141***
	(0.023)	(0.022)	(0.025)	(0.025)	(0.023)	(0.023)
OAT-10Y	-0.349***	-0.421***	-0.345***	-0.415***	-0.345***	-0.412***
	(0.025)	(0.024)	(0.025)	(0.025)	(0.025)	(0.025)
Lapse Rate	-0.069***	-0.089***	-0.070***	-0.089***	-0.074***	-0.090***
	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.009)
PPB Ratio (BoY)	0.011***	0.063***	0.012	0.063***	0.017**	0.067***
	(0.008)	(0.020)	(0.008)	(0.020)	(0.008)	(0.020)
Capital Gain Ratio			-0.018	-0.022		
			(0.019)	(0.020)		
Equity as % of Assets					-0.008***	-0.009**
					(0.003)	(0.004)
Constant	0.014***	0.017***	0.014***	0.017***	0.015***	0.018***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Nobs	936	936	936	936	934	934
F statistic	91	125	73	100	75	104
R^2	0.33	0.62	0.33	0.62	0.34	0.62
Adjusted R^2	0.33	0.58	0.33	0.58	0.34	0.58

Note: This table contains the estimated parameters and their robust standard errors in parentheses (White) for the static models, with both pooled-OLS and fixed effects (FE) specifications. Models $8.a$ and $8.b$ measure the additional effect of the ALM variables. The constants correspond to the mean of fixed effects for FE models. *p<0.1; **p<0.05; ***p<0.01.

Table 7: Estimating the dynamic model.

	Participation Rate Spread $\rho_{i,t}$											
	Autocorrelation		Model 9		Model 10		Model 11		Model 12		Model 4	
	OLS	FE	OLS	FE	OLS	FE	OLS	FE	OLS	FE	OLS	FE
Lag of Participation Rate Spread	0.581***	0.343***	0.508***	0.250***	0.469***	0.179***	0.424***	0.157***	0.426***	0.161***		
	(0.041)	(0.053)	(0.038)	(0.050)	(0.035)	(0.046)	(0.036)	(0.046)	(0.036)	(0.044)		
Asset Return − OAT-10Y			0.139***	0.208***	0.093***	0.117***	0.121***	0.116***	0.120***	0.110***	0.193***	0.129***
			(0.020)	(0.029)	(0.018)	(0.025)	(0.019)	(0.024)	(0.019)	(0.024)	(0.023)	(0.022)
OAT-10Y					-0.295***	-0.346***	-0.301***	-0.368***	-0.310***	-0.403***	-0.349***	-0.421***
					(0.022)	(0.023)	(0.021)	(0.023)	(0.022)	(0.023)	(0.025)	(0.024)
Lapse Rate							-0.047***	-0.068***	-0.045***	-0.074***	-0.069***	-0.089***
							(0.006)	(0.009)	(0.006)	(0.009)	(0.007)	(0.009)
PPB Ratio (BoY)									0.018**	0.064***	0.011	0.063***
									(0.008)	(0.021)	(0.008)	(0.020)
Constant	-0.000*	-0.001	-0.002***	-0.003***	0.010***	0.011***	0.013***	0.016***	0.012***	0.016***	0.014***	0.017***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Nobs	842	842	842	842	842	842	842	842	842	842	936	936
F statistic	203	42	135	45	169	119	152	103	124	111	91	125
R^2	0.34	0.46	0.39	0.53	0.49	0.63	0.52	0.65	0.53	0.67	0.33	0.62
Adjusted R^2	0.34	0.39	0.39	0.47	0.49	0.59	0.52	0.61	0.52	0.62	0.33	0.58

Note: This table contains the estimated parameters and their robust standard errors in parentheses (White) for the dynamic models, with both pooled-OLS and fixed effects (FE) specifications. Model 9 captures the participation rate spread dynamic and Models 10 − 12 consider the effect of additional variables. The results obtained with Model 4 are displayed for comparison purpose. The constants correspond to the mean of fixed effects for FE models. *p<0.1; **p<0.05; ***p<0.01.

Table 8: Time stability of the static model (Model 4).

	Participation Rate Spread $\rho_{i,t}$					
	Model 4 - Entire period		Model 4 - [1999, 2006]		Model 4 - [2006, 2013]	
	OLS	FE	OLS	FE	OLS	FE
Asset returns - OAT	0.193***	0.129***	0.201***	0.109***	0.145***	0.062*
	(0.023)	(0.022)	(0.032)	(0.027)	(0.030)	(0.032)
OAT-10Y	-0.349***	-0.421***	-0.306***	-0.420***	-0.499***	-0.592***
	(0.025)	(0.024)	(0.048)	(0.036)	(0.043)	(0.042)
Lapse rate	-0.069***	-0.089***	-0.091***	-0.101***	-0.040***	-0.053***
	(0.007)	(0.009)	(0.010)	(0.012)	(0.009)	(0.010)
PPB ratio BoY	0.011***	0.063***	0.005	0.089**	0.017	0.084**
	(0.008)	(0.020)	(0.010)	(0.038)	(0.012)	(0.035)
Constant	0.014***	0.017***	0.014***	0.018***	0.017***	0.020***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)
Nobs	936	936	492	492	511	511
F statistic	91	125	35	49	80	110
R^2	0.33	0.62	0.32	0.69	0.38	0.70
Adjusted R^2	0.33	0.58	0.31	0.63	0.38	0.65

Note: This table contains the estimated parameters and their robust standard errors in parentheses (White) for the static models, with both pooled-OLS and fixed effects (FE) specifications. We test the time stability of the estimated coefficients on two sub-periods ([1999, 2006] and [2006, 2013]). The constants correspond to the mean of fixed effects for FE models. *p<0.1; **p<0.05; ***p<0.01.

Table 9: Average participation rate spread over the performance subgroups.

	Panel A	Panel B	Panel C	Panel D
Mean	-0.00353***	-0.00140***	-0.00054	0.00124**
	(0.00085)	(0.00042)	(0.00062)	(0.00062)

Note: This table contains the estimated average participation rate spread for each performance subgroups (Panels A-D) with their robust standard errors in parentheses (White). *p<0.1; **p<0.05; ***p<0.01.

Table 10: Estimation of Model 4 by performance subgroups .

	Participation Rate Spread $\rho_{i,t}$											
	Model 4 - Entire set		Model 4 - Panel A		Model 4 - Panel B		Model 4 - Panel C		Model 4 - Panel B&C		Model 4 - Panel D	
	OLS	FE	OLS	FE	OLS	FE	OLS	FE	OLS	FE	OLS	FE
Asset Return and OAT-10Y	0.193	0.129	0.226	0.152	0.236	0.213	0.066	0.056	0.116***	0.116***	0.078	0.093
	(0.023)***	(0.022)***	(0.054)***	(0.054)***	(0.055)***	(0.048)***	(0.037)*	(0.033)*	(0.031)	(0.029)	(0.047)	(0.043)**
OAT-10Y	-0.349	-0.421	-0.327	-0.521	-0.344	-0.370	-0.449	-0.438	-0.414***	-0.426***	-0.281	-0.362
	(0.025)***	(0.024)***	(0.075)***	(0.073)***	(0.048)***	(0.046)***	(0.046)***	(0.043)***	(0.032)	(0.031)	(0.048)***	(0.050)***
Lapse Rate	-0.069	-0.089	-0.024	-0.041	-0.088	-0.132	-0.076	-0.037	-0.085***	-0.084***	-0.085	-0.097
	(0.007)***	(0.009)***	(0.030)	(0.039)	(0.014)***	(0.016)***	(0.012)***	(0.020)*	(0.009)	(0.013)	(0.012)***	(0.014)***
PPB Ratio	0.011	0.063	0.035	0.071	0.014	0.056	0.022	0.033	0.016	0.054**	-0.015	0.073
	(0.008)	(0.020)***	(0.012)***	(0.041)*	(0.014)	(0.030)*	(0.019)	(0.042)	(0.012)	(0.027)	(0.018)	(0.038)*
Constant	0.014	0.017	0.009	0.016	0.015	0.018	0.019	0.016	0.018***	0.018***	0.015	0.017
	(0.001)***	(0.001)***	(0.003)***	(0.003)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.001)	(0.002)	(0.002)***	(0.002)***
Nobs	936	936	160	160	285	285	252	252	537	537	239	239
F statistic	91	125	13	27	48	64	36	33	79	88	22	26
R^2	0.33	0.62	0.36	0.70	0.40	0.64	0.30	0.49	0.34	0.55	0.33	0.65
Adjusted R^2	0.33	0.58	0.34	0.65	0.40	0.60	0.29	0.43	0.33	0.50	0.32	0.61

Note: This table contains the estimated parameters and their robust standard errors in parentheses (White) for Model 4, with both pooled-OLS and fixed effects (FE) specifications over the performance subgroups. The constant correspond to the mean of fixed effects for FE models. *p<0.1; **p<0.05; ***p<0.01.