The Regulation of Competitive Pension Funds with Endogenous Financial Literacy

Valentina Catapano* Luciano Greco†

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Abstract

The long-run trend towards retirement schemes based on competitive, defined-contribution pension funds has motivated a growing interest in financial literacy as a tool to mitigate agency problems and myopic behaviors in pension investments. In this paper, we focus on the adverse selection problem affecting a market in which pension funds compete to attract households' savings, and we model the investment in financial literacy as a costly screening technology. Relying on such a theoretical framework, we show that the (optimal) level of financial literacy is affected by several policy parameters, particularly the size of mandatory pension savings. Then, on the basis of a cost-benefit analysis, we assess alternative regulatory frameworks including policy tools such as the level of transparency that pension funds have to comply with and the public provision of investments in financial literacy.

Keywords: Adverse selection, Screening, Individual retirement plans, Financial education programs
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1 Introduction

Over the past thirty years, structural demographic and economic trends have led several countries to reform pension systems to expand the role of funded schemes

*CRIEP, Italy
†E-mail address: luciano.greco@unipd.it. Department of Economics and Management, University of Padua, & CRIEP, Italy.

and, particularly, to foster the transition from defined-benefit (DB) to defined-contribution (DC) schemes and competition among pension funds (OECD, 2019). The prevalent trend towards competitive, DC pension funds mitigates the long-run financial sustainability risks underlying DB pension schemes. However, it also exposes future retirees to the risk of receiving inadequate pensions. The latter arises because of several reasons ranging from pension industry inefficiency (e.g., high management fees and/or poor financial performance) to naive choices of households. In turn, enhancing financial skills of members of DC pension plans is becoming increasingly important (Rouzet et al., 2019). Households rely less on social security systems and have to take on more responsibility for saving, investing and decumulating their assets, thus paying more attention to the design of their retirement plans (Lusardi and Mitchell, 2014). These considerations raise concerns about households' ability to deal with financial industry and planning for retirement, since the level of financial literacy is low around the world.

Given the economic importance of financial literacy, policy makers in several countries are supporting with great enthusiasm financial education programs aiming at improving financial awareness, knowledge and rational behaviors. However, making everyone financially savvy is not feasible (Lusardi and Mitchell, 2014) and there is no conclusive evidence supporting the effectiveness of financial education programs (Entorf and Hou, 2018).

Thus, strengthening the regulatory framework of funded, private pension schemes is likely to be a complementary, unavoidable alternative to protect households against financial hazards underlying the operation of such schemes, particularly when they aim at complementing public pension systems and are, therefore, mandatory (OECD, 2016).

As highlighted by Jappelli and Padula (2013) and Lusardi et al. (2017), investments in financial literacy is an endogenous choice variable of households. Like other forms of human capital, financial literacy is costly to accumulate. In turn, the regulation of the pension fund industry (as well as other segments of the financial retail sector) has to take into account the possible trade offs that the endogeneity of financial literacy entails. This is the aim of our contribution. Building on this intuition and on the above mentioned stylized facts, we consider a theoretical model where financial literacy is an individual investment in human capital which improves individual's "information" about financial features of pension plans (i.e., the risk-return financial structure). In turn, financial literacy is modeled as a costly screening technology which enables (informed) individuals to reduce the typical adverse selection problem which affects the functioning of a market where pension funds compete to attract individual savings (Greco, 2006). In this framework, we show that the optimal level of financial literacy – which is chosen by households – interacts with several policy parameters determined by the government, such as the size of mandatory pension savings, the level of transparency that pension funds have to comply with, and the public provision of investments in financial literacy. Relying on a cost benefit analysis (without any political agency concern), we assess alternative regulatory frameworks of the market of competitive pension funds.

The remainder of the paper is organized as follows. Section 2 reviews the literature related to the financial literacy and the regulation of funded pension systems. Section 3 outlines the theoretical model. Section 4 analyses the equilibrium of the market of pension funds and the optimal investment in financial literacy. Section 5 assesses policy options. Section 6 concludes.

2 Related literature

The meaning of financial literacy involves a combination of financial knowledge, behaviour and attitudes. A financially literate individual is more able to handle everyday financial decisions regarding consumption, investments and savings. Financial literacy is necessary to make informed decisions about wealth accumulation, financial planning, debt and pensions. However, many people do not understand basic financial concepts and the level of financial literacy is low around the world: on average across G20 countries, the minimum target score defined as correctly answering 70% of the financial knowledge questions is achieved by less than half of adults (OECD, 2017). Moreover, there is heterogeneity in levels of financial literacy across the population. Some evidences are, for instance: women are less financially literate than men; the profile of financial literacy along the life cycle is hump-shaped, meaning that young and elderly people are less financially literate; individuals with higher education are more financially savvy. This may suggest that financial education programs should be tailored to address specific groups (Lusardi and Mitchell, 2014).

Numerous studies analyse empirically the relationship between financial literacy and individual economic behaviour, finding the former correlated to several financial outcomes, such as enhancing financial well-being and intertemporal decision-making. However, financial literacy lacks consensus on its impact, because some authors find no significant effects of financial literacy programs on the financial behaviour (Nieddu and Pandolfi, 2020). Financial education may have some limitations in improving long-term financial outcomes (Carpena et al., 2015). The inconsistent evidence on the effectiveness of financial education may depend on which financial

outcome to improve. For instance, automatic enrollment is more cost effective than financial education programs in increasing employer-sponsored plan participation and contributions (Hastings et al., 2012).

There is a puzzle of low stock market participation, due to lack of financial literacy. As a consequence, financially illiterate investors may systematically underinvest in risky financial products. On the other hand, investors endowed with adequate financial knowledge may have a more efficient risk-taking behaviour. Financial literacy plays an important role at the moment of investment decisions (Nieddu and Pandolfi, 2020).

Financial literacy affects economic preferences, whose two important domains are risk and time preferences. Risk preferences and time preferences are closely related to each other and are taken into account in financial decisions. By using a field experiment, an educational intervention on financial literacy addressed to students, aged 16 years on average, increases their risk aversion and patience in the aggregate, and the effect on both preferences is joint. Risk preferences are measured using certainty equivalents and time preferences are measured using future premium. The financial literacy intervention increases financial literacy, improving financial decisions of citizens. Individuals behave more frequently in a time-consistent manner. Larger improvements in financial literacy lead individuals to become less risk-averse, thus offsetting the increase in risk aversion without overcoming it. The financial literacy intervention is justified by the increasing complexity of financial decisions (Sutter et al., 2020).

Low levels of financial literacy raise concerns about households' ability to deal with financial industry and, particularly, with planning for retirement over the life cycle. Moreover, the evolving context, characterized by financial innovation and

increasing markets integration, on one hand, and by opportunity of living longer stressing the need of planning for a longer term, on the other, is becoming increasingly complex and highlights the importance of increasing financial sophistication. Using the Bank of Italy's Survey on Household Income and Wealth, Fornero and Monticone (2011) show that financial literacy positively and significantly affects the probability of participating in a pension fund. In this regard, public intervention aimed at improving the level of financial literacy is reasonable. Nudging jointly financial literacy and demographic literacy, which arises from the need to plan for the long term given the rising longevity, allows to design a more effective financial literacy program (Billari et al., 2017).

On the other hand, Nolan and Doorley (2019), using data from the Irish Longitudinal Study on Ageing, find that there is no association between financial literacy and supplementary pension coverage, stressing the limited role for financial literacy over other determinants of participation in supplementary pension schemes such as income, education and employment type. However, they find that higher financial literacy is associated with higher total household wealth, greater expectations of income in retirement and lower financial stress.

Financial literacy may be considered a particular form of human capital accumulation. Therefore, some individuals are willing to invest in financial literacy while others may rationally choose not to invest in it. Financial markets are increasingly accessible, households face financial decisions increasingly complex and have a much greater responsibility. All these changes are increasingly requiring a financial literacy intervention. In particular, the pension environment is characterized by a trend toward disintermediation: workers and retirees rely less on Social Security and have to take on more responsibility for saving, investing, and decumulating their assets.

This is consistent with the shift from employer-sponsored DB pension plans to DC pension plans and Individual Retirement Accounts. Individuals have to pay more attention to the design of their retirement plans, hence it is worth making financial literacy endogenous and integrating it in an intertemporal consumption model (Lusardi and Mitchell, 2014).

In this way, Jappelli and Padula (2013) integrate investment in financial literacy in an intertemporal consumption model. customers choose how much to invest to acquire financial literacy facing a trade-off between benefits, in terms of better investment opportunities and increasing net returns to saving, and costs, in terms of money, time and effort. customers allocate their income among consumption, saving and investment in financial literacy. Decision to acquire financial literacy and saving decisions depend on the same factors, such as preference parameters, households' resources and costs of literacy. Reforms that develop private pension funds enhancing financial markets raise the incentive to invest in financial literacy. On the contrary, individuals living in countries with more generous public pension systems have less incentives to invest in financial literacy, showing lower levels of financial literacy.

Lusardi et al. (2017) build a stochastic life-cycle model that incorporates endogenous financial knowledge, exploring implications for wealth inequality. Financial knowledge may allow customers to allocate their savings in sophisticated financial products, raising their returns on savings. However, financial knowledge acquisition is expensive and some customers may rationally choose not to invest in it. Financial education programs may be ineffective for customers who find it optimal to remain financially ignorant. Financial knowledge may explain 30-40% of wealth inequality at retirement.

Financial literacy has a positive impact on retirement planning behaviour. Financial literacy is positively correlated with wealth accumulation over the life cycle, with likelihood to invest in the stock market, with returns from savings accounts and with propensity to plan for retirement, because financial literacy reduces costs of collecting and processing information and planning costs (van Rooji et al., 2012). However, financial literacy is expensive, there are direct, indirect and opportunity costs, which are likely to be high for both individuals and society. Moreover, financial education decays over time and Entorf and Hou (2018) find no clear evidence on the effectiveness of financial education interventions in increasing financial literacy levels. If the costs of financial literacy were too high, it could be better that households assume less responsibility for their retirement plans giving way to regulation. There may be a trade-off between financial literacy and regulation: the former has interesting implications but it is not free of costs, the latter has some limits but it may also be effective in designing funded pension systems. This opens a debate about the role of financial literacy versus regulation. However, they may be complementary, not necessarily substitutes (Lusardi and Mitchell, 2014). The optimal policy mix between financial literacy and regulation should be investigated.

Government intervention may be needed to improve financial knowledge and financial outcomes, by solving under-investment in financial education, by regulating disclosure rules and by providing unbiased information and advice (Hastings et al., 2012). In recent years, policy-makers have introduced several information policies in order to increase transparency in retail financial markets and improve investors' awareness (Nieddu and Pandolfi, 2020).

The annual pension statement is a document that provides information on projected pension benefits to members of funded DC pension plans, in compliance with

regulatory disclosure rules. It aims at enhancing member empowerment, improving members' level of knowledge and understanding, and encouraging members' action, especially in response to the risks that members bear under DC pension plans. Therefore, the pension statement may be considered as an integral component of the wider financial literacy program (Antolín and Harrison, 2012).

Households make systematic mistakes in planning and saving for retirement, which is the rationale behind mandatory savings schemes. Indeed, households behave in a passive way to some extent, they do not change frequently their strategies, they join favourable plans slowly and they diversify their portfolios naively, adopting heuristics. On the other hand, DC pension plans require more responsibility in the decision making process for households (Benartzi and Thaler, 2007).

Mandatory pension systems are characterized by the rigidity of the demand for pension products. There is a misalignment between the incentives of the pension fund management companies, which focus excessively on short-term return maximization motivated by personal and reputational incentives, and the long-term objectives of the members. This misalignment should be solved and mandatory funded pension systems should offer life-cycle investment strategies acting as smart default options for individuals, since individuals are not able to make informed decisions related to long-term horizons. The supervisory of DC pension plans should aim at ensuring that pension funds act in compliance with investment regulation (Castañeda and Rudolph, 2011).

Considered that many individuals are not able to make active investment decisions, the design of default options has a great importance among policymakers. Investment strategies of default options need to pursue the long-term interest of individuals. The number of investment options provided has not to be excessive,

because it may lead to information overload and bigger complexity, thus increasing the use of the default option by participants (Tapia and Yermo, 2007).

Using a behavioral contract theory approach, Bubb and Warrant (2020) develop two competing theories about how employers should design their retirement plans: an equilibrium model and a paternalistic employer model, which serves as a benchmark against which to assess the predictions of the equilibrium model. An employer-sponsored retirement plan is made up of a non-elective employer contribution, employer matching contributions proportional to workers' retirement savings and a default employee contribution rate. Workers are automatically enrolled in employer-sponsored retirement plans, but they can opt out if they do not want to participate. Firms offer labour contracts specifying a wage and a retirement plan and workers choose a contract among offers by maximizing their utility, given a time-inconsistent, present-bias factor. The authors call into question the employer acting as a paternalistic social planner and so designing retirement plan to maximize social welfare, because the delegation to employers of retirement plan design could result in perverse outcomes. Moreover, employer in designing a paternalistic retirement plan must have paternalistic motivations and significant market power, which is not satisfied given competition in the labour market. Employer-sponsored plans are subject to strict regulations, which would be not necessary if employers acted as paternalistic social planners. Empirically, the majority of employer-sponsored plans complies with the predictions of the equilibrium model since they set default contribution rates strictly below the cap on employer matching contributions, whereas a minority of employer-sponsored plans sets default contribution rates at the cap on employer matching contributions in compliance with the paternalistic model. Empirically, the default savings rate in automatic enrolment plans is lower than the

savings rate workers would have chosen opting in on their own, but it raises participation rates of workers who would not have opt in on their own. The equilibrium default choices minimize workers' savings and are lower than the minimum workers must contribute to get the full employer matching contributions.

Employers are intermediaries between retirement saving funds and savers. Employers acts as de facto market regulators through their retirement plan design. Default rules must be carefully designed, because they can lead to default bias such as weak participation in retirement savings. Savers benefit from employers' paternalism to the extent that employers serve savers' interests (Spiegler, 2015). Saving for retirement is low due to low levels of financial literacy, even when coverage of the working-age population is high (Rouzet et al., 2019).

3 The model

In our model a large number (i.e., mass 1) of households is mandated by government to save in defined-contribution pension funds. We assume that the amount of pension savings, s, exogenously fixed by the government (or regulator).[1] Individuals may invest in financial literacy and, then, choose among pension plans with different risk-return features that are offered in the pension fund market. The government may also intervene to regulate the pension fund market with different tools. Financial literacy works as a costly screening technology which improves the chances that individuals may become *informed* – i.e., they are able to discern the risk-return quality of the pension plans that are offered in the market.

The model goes through four sequential stages (Figure 1):

[1] It is consistent with the pension system's second pillar, for which individuals compulsorily save a certain amount.

1. a benevolent government (or regulator) establishes the regulatory framework of the market of pension funds: the level of pension savings, the transparency standards about financial information that pension fund managers have to provide to customers, possible subsidies to investments in financial literacy, possible establishment of a public option as an alternative to private pension funds;

2. individuals (or customers) choose consumption and investment in financial literacy, optimizing their life-cycle, expected utility;

3. pension funds offer pension plans to individuals in a market that is affected by adverse selection;

4. depending on the investment in financial literacy, individuals may (or may not) become informed about pension plans and, then, choose one of such plans, maximizing their expected utility.

The institutional setting of the funded pension scheme is a competitive market of pension funds, where customers may switch between pension funds in order to maximize their expected pension and there are no barriers to entry, thus pension funds make zero expected profits in the long run. At the beginning of period 1, pension savings yield a gross rate of return which is the realization of the (ex ante) random variable $\widetilde{R} \sim N(\mu, \sigma^2)$. For the sake of simplicity, we assume that there are only two financial products (or pension plans), which differ in the mean and variance of the return on investment. One financial product provides a low expected return μ_L but it is less risky σ_L^2. While the other pension plan allows to gain a higher expected return $\mu_H > \mu_L$ but it is riskier $\sigma_H^2 > \sigma_L^2$.

Consistently, we assume that there are only two types of pension funds, depending on their asset-management skills. High-skill pension funds invest to accumulate asset-management skills which allows them to yield a high return μ_H on average.[2] On the other hand, low-skill pension funds do not face any cost to accumulate asset-management skills and yield a low average return μ_L. The pension fund's profit is represented as:

$$\Pi_i = \omega_i s_i - a_i - k(\gamma)s_i \qquad \text{with } i = L, H \tag{1}$$

where ω_i are management fees, which are represented as a share of managed pension savings ${s_i}^3$, a_i are fixed (but not sunk) costs to accumulate asset management skills – i.e., $a_H = a$ and $a_L = 0$, and $k(\gamma)s_i$ are transparency costs that pension funds have to bear to comply with the directives of the regulator. Transparency costs are independent of skills, increase linearly with managed pension savings ${s_i}^4$ and increase with the transparency factor γ (i.e., $k'_\gamma > 0$) tending asymptotically to a maximum $\overline{k}$. We make two additional *assumptions on the technology of high-skill pension funds*: $\overline{k} \leq 1 - \frac{a}{\pi s \frac{\mu_H - \mu_L}{\mu_H}}$ and $a < \pi s \frac{\mu_H - \mu_L}{\mu_H}$ (the latter assumption implies that the right-hand side of the former one is strictly positive). As we show below, those assumptions imply that investing in high risk-return pension plans is rational.

Let us remark that, by the assumed structure of the cost of pension funds, the operational scale which minimizes the costs of low-skill pension funds is zero

[2] A more sophisticated investment technology provides customers access to higher expected returns, but pension funds face costs to get it, for example by hiring good asset managers that have to be adequately rewarded.

[3] The structure of pension-fund fees is complex. For the sake of simplicity, we assume that pension funds charge to customers only management fees which are proportional to managed savings.

[4] Assuming that transparency costs increase with the sum of managed savings has economic sense, because they increase with the number of customers. For example, the MiFID questionnaire designed by the Markets in Financial Instruments Directive (MiFID) of the European Union to fulfill transparency requirements is submitted to each customer.

(i.e., a trivial number of customers or managed assets). Conversely, the sector of high-skill pension funds is a natural monopoly. However, because of free entry and no-sunk costs assumptions, also the monopolistic high-skill pension fund has to put management fees equal to average costs. The considered cost structure is assumed for the sake of simplicity, while our main results hold also with increasing marginal costs.

We assume that individuals live for two periods: in period 0 each of them works, and in period 1 she is retired. Given compulsory pension savings s, in period 0, each individual earns a labor income y, and allocates it among consumption c_0 and investment in financial literacy $l(\pi, \gamma)$, where π is the probability of being informed on the quality of pension plans (i.e., the effectiveness of the financial literacy investment) and γ is the degree of transparency imposed by the regulator to pension fund managers. Given γ, the individual aiming at being informed with larger probability π has to invest more in it (i.e., $l'_\pi(\pi, \gamma) > 0$), though the investment in financial literacy raises the probability of getting the signal at a decreasing rate (i.e., $l''_{\pi\pi} < 0$).[5] Moreover, we assume that $l'_\pi(0, \gamma) = 0$ and $\lim_{\pi \to 1} l'_\pi(\pi, \gamma) = \infty$. Finally, we also assume that more transparency reduces the investment cost given π, i.e., $l'_\gamma < 0$. The intuition is that transparency improves the effectiveness of financial literacy invesments, because it facilitates the acquisition of information.

[5]The convexity of the investment function $l(\pi, \gamma)$ is in line with the human capital literature, since financial literacy may be considered a particular form of investment in human capital. There are decreasing marginal returns to an additional investment in human capital. Throughout the paper we use the following notational standard: $\frac{\partial l(\pi,\gamma)}{\partial \pi} = l'_\pi(\pi, \gamma)$ or $\frac{\partial l(\pi,\gamma)}{\partial \pi} = l'_\pi$; $\frac{\partial^2 l(\pi,\gamma)}{\partial \pi^2} = l''_{\pi^2}$; $\frac{\partial^2 l(\pi,\gamma)}{\partial \pi \partial \gamma} = l''_{\pi\gamma}$.

Individuals maximize the following intertemporal utility function[6]:

$$c_0 + \beta \left[E(c_1) - \frac{1}{2}\rho Var(c_1) \right], \tag{2}$$

which depends on the first period consumption c_0, and on the expectation of the utility of the retirement period, which is given by the expected consumption c_1, corrected for the associated risk-premium.[7] $\beta \in (0,1)$ is the time discount factor and $\rho > 0$ is the constant absolute risk aversion coefficient. The optimization problem is subject to the time-contingent budget constraints:

$$y \geq c_0 + s + l(\pi, \gamma) \qquad \text{and} \qquad \widetilde{R}s(1-\omega_i) \geq c_1. \tag{3}$$

Individuals are price-taker and look at pension funds' management fees. With probability π, customers received a signal that allows them to perfectly distinguish the risk-return structure of financial products. Therefore, informed customers choose the financial product that optimizes the risk-return trade-off according to their risk aversion. With probability $1-\pi$, customers did not receive the signal and cannot distinguish between financial products. Informed customers are able to choose pension plans based on their preferred risk-return profile. Conversely, uninformed customers are unable to identify risk-return features of pension plans and base their choices on the rational expectation about the distribution of the two financial products in the market. Therefore, there is a problem of incomplete information.

The government (or regulator) aims at maximizing the expected utility of indi-

[6]The objective function is the linearization of the utility of a discounted stream of consumption.

[7]We introduce here the simplifying assumption that income effects (i.e., the effects of the level of y) do not influence investments in financial literacy. However, as shown by Jappelli and Padula (2013), a higher income increases the optimal investment in financial literacy.

viduals and chooses transparency and subsidies to investments in financial literacy.

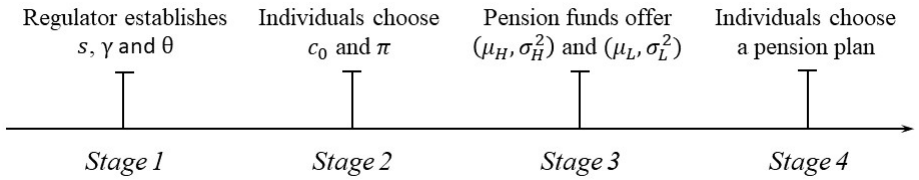

Figure 1: *Timeline*

4 The market of pension funds

Since we assume free entry, at the equilibrium of the pension funds' market, management fees charged to customers are such that accrued revenues cover outlays, as follows:

$$\omega_L = k(\gamma) < \omega_H = \frac{a}{s_H} + k(\gamma), \tag{4}$$

where s_H is the market share of the high-skill pension fund. Therefore, the individuals who buy *high* (risk-return) pension plans during their working life have an expected utility during retirement which is equal to:

$$\underbrace{\mu_H s(1-\omega_H)}_{E(c_1)} - \frac{1}{2}\rho \underbrace{\sigma_H^2 s^2 (1-\omega_H)^2}_{Var(c_1)}; \tag{5}$$

and individuals who buy *low* (risk-return) pension plans have an expected utility equal to:

$$\underbrace{\mu_L s(1-\omega_L)}_{E(c_1)} - \frac{1}{2}\rho \underbrace{\sigma_L^2 s^2 (1-\omega_L)^2}_{Var(c_1)}. \tag{6}$$

The informed individuals may choose between different risk-return pension plans.

Given our assumption of representative agent, all individuals choose the same investment in financial literacy and, hence, π of them become actually informed. Solving by backward induction, we can see that the informed individuals would choose the high pension plan over the low one provided that (5) is larger or equal to (6). The latter condition depends on individual's risk aversion. Particularly, it is useful to define the following threshold:

$$\hat{\rho} = \frac{2[(1-\omega_H)\mu_H - (1-\omega_L)\mu_L]}{s[(1-\omega_H)^2\sigma_H^2 - (1-\omega_L)^2\sigma_L^2]}. \tag{7}$$

By the *assumptions on the technology of high-skill pension funds*, we have the following

Lemma 1 *If* $k(\gamma) < 1 - \frac{a}{\pi s \frac{\sigma_H - \sigma_L}{\sigma_H}}$, *then* $\hat{\rho} > 0$ *and only individuals with* $\rho < \hat{\rho}$ *invest in high pension plans. If* $k(\gamma) \geq 1 - \frac{a}{\pi s \frac{\sigma_H - \sigma_L}{\sigma_H}}$, *then* $\hat{\rho} < 0$ *and all individuals invest in low pension plans.*

Proof. By (4), $(1-\omega_H)\mu_H - (1-\omega_L)\mu_L$ can be written as $1 - \frac{a}{\pi s \frac{\mu_H - \mu_L}{\mu_H}} > k(\gamma)$, which is always satisfied by assumptions that $1 - \frac{a}{\pi s \frac{\mu_H - \mu_L}{\mu_H}} > \overline{k}$ and that, for all γ, $\overline{k} \geq k(\gamma)$. If $(1-\omega_H)^2\sigma_H^2 > (1-\omega_L)^2\sigma_L^2$ – that, by (4), can be written as $k(\gamma) < 1 - \frac{a}{\pi s \frac{\sigma_H - \sigma_L}{\sigma_H}}$, then $\hat{\rho} > 0$ and (5) is larger or equal to (6) if and only if $\rho < \hat{\rho}$. If $(1-\omega_H)^2\sigma_H^2 \leq (1-\omega_L)^2\sigma_L^2$ – that, by (4), can be written as $k(\gamma) \geq 1 - \frac{a}{\pi s \frac{\sigma_H - \sigma_L}{\sigma_H}}$, then $\hat{\rho} < 0$ and (5) is always larger or equal than (6). ■

Pension funds are strategic and exploit the informational advantage that they have towards uninformed customers. A pension fund acts as an intermediary: it collects the contributions and invests them. Adverse selection may cause a mar-

ket failure. However, customers may reduce the scope of a failure by investing in financial literacy.

4.1 The symmetric information benchmark

Under symmetric information, all customers are informed without investing in financial literacy. In turn, the government would not have any reason to introduce transparency requirement. In equilibrium, there are no transparency costs, the low-skill funds' management fee is zero and the high-skill funds' management fee depends only on the skill-accumulation costs. Depending on their risk-aversion, customers select their preferred pension plan. Therefore, the market equilibrium is efficient.

4.2 Asymmetric information and costly screening

Under asymmetric information (and assuming away any screening or signaling technology), uninformed customers cannot observe the skills of pension funds. Choosing to which pension fund uninformed customers allocate their savings leads to an adverse selection problem. Low-skill pension funds facing uninformed customers may pretend to be highly skilled, demanding the high management fee ω_H without facing the skill-accumulation costs. Therefore, they would make a positive profit by mimicking high-skill funds, instead uninformed customers get the low expected return although they paid the high management fee. As a consequence, at the second-best equilibrium, uninformed customers cannot be rationally willing to pay any management fee which is larger than ω_L. Therefore, only low-skill pension funds will operate in the market. From these arguments, we have the following proposition:

Proposition 1 *The equilibrium of the market of pension funds is Pareto-inefficient*

when all customers are uninformed.

High-skill pension funds would like to convince uninformed customers that their pension plans yield a high return on average for real. However, simply telling it is not sufficient to obtain a higher price, otherwise all pension funds, also low-skill ones, would state their products are sophisticated.

Absent effective signaling technologies on the (high-skill) pension funds' side, customers may invest in costly monitoring (i.e., financial literacy) to detect the quality of pension plans. With positive investments in costly screening, individuals will become informed. In such a game, the (perfect Bayesian) equilibrium can be pooling when high- and low-skill pension funds choose the same strategy, or separating when high- and low-skill pension funds have different strategies. However, under perfect competition, a pooling equilibrium does not exist, because a contract based on one-size-fits-all is not robust to competition. Indeed, high-skill pension funds have to receive a fee high enough to cover skill-accumulation costs, but it generates an extra profit for low-skill pension funds because that fee is higher than their costs. As long as expected profits are positive, new funds enter as low-skill pension funds, because no fund is willing to be highly skilled. A separating equilibrium of the market of pension funds is a perfect Bayesian equilibrium such that, given customers' beliefs: on the one hand, high-skill pension funds sell only to informed customers, and on the other, low-skill pension funds sell to (very risk-averse) informed customers and to uninformed customers. Informed customers are able to choose to which pension fund they allocate their savings on the basis of their risk aversion coefficient, while uninformed customers can buy only the low return-and-risk product. However, when uninformed customers are not so much risk averse

and prefer the high return-and-risk product, their preferences cannot be fulfilled, otherwise they expose themselves to the risk of a low-skill pension fund that mimics high-skill ones. The Figure 2 shows the equilibrium of the market of pension funds when the risk aversion coefficient is below the threshold (7). Instead, when the risk aversion coefficient is above the threshold (7), no high-skill pension fund enters the market because all customers prefer the low return-and-risk product.

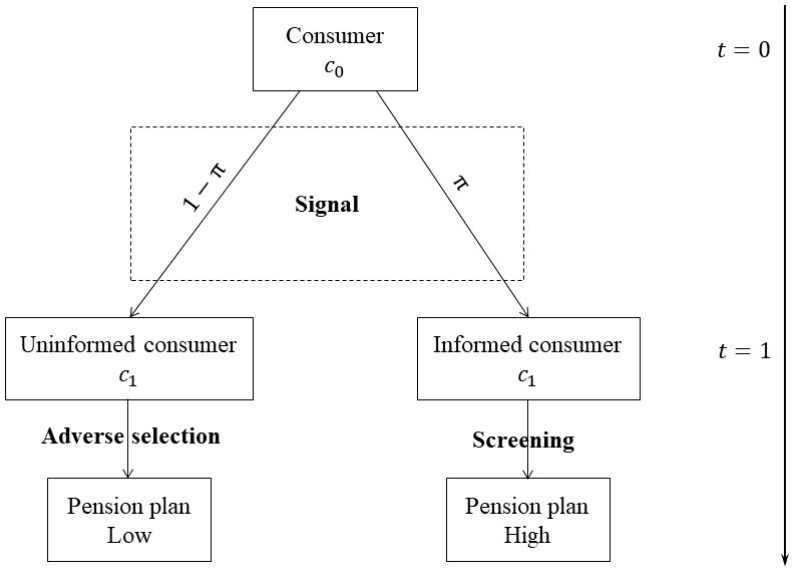

Figure 2: *Sequential game for $\rho < \hat{\rho}$ (with $\hat{\rho}$)*

4.3 The behavior of individuals

Individuals act given the regulatory framework established by the government and the functioning of the market. When the risk aversion coefficient is above the threshold (7), customers are so risk averse that prefer the low return-and-risk product. However, they are always satisfied because informed customers would be able to distinguish and choose low-skill pension funds, while uninformed customers can

only bargain with low-skill pension funds in the market with adverse selection. As a result, customers have no incentive to make an investment in financial literacy:

Proposition 2 *When customers are very risk averse (i.e., $\rho > \hat{\rho}$) or the high pension plan is very risky (i.e., $\hat{\rho} < 0$), the optimal investment in financial literacy is zero, because all customers are willing to allocate their savings to low-skill pension funds that are the only ones to operate under adverse selection.*

Proof. This proposition follows from the classical lemon-market argument. Substituting the budget constraints (3), the expected value and the variance of the consumption in period 1 in (2) – i.e., the expected value of the consumption in period 1 is certain, $E(c_1) = s(1-\omega_L)\mu_L$, and there is no variance, we find that the first order condition with respect to π we find that such a probability cannot be positive. ■

On the other hand, when the risk aversion coefficient is below the threshold (7) (and the high pension plan is not too risky, i.e., $\hat{\rho} > 0$), customers prefer the high pension plan. We compute the expected value and the variance of the consumption in period 1:

$$E(c_1) = \pi s(1-\omega_H)\mu_H + (1-\pi)s(1-\omega_L)\mu_L \tag{8}$$

$$Var(c_1) = \pi(1-\pi)s^2[(1-\omega_H)\mu_H - (1-\omega_L)\mu_L]^2 \tag{9}$$

For simplicity, we define:

$$\Delta = (1-\omega_H)\mu_H - (1-\omega_L)\mu_L \tag{10}$$

which is the yield spread net of the management fees between the high return-and-risk fund and the low return-and-risk fund. By our assumptions on the technology

of high-skill pension funds,

$$\Delta = (\mu_H - \mu_L)\left(1 - \frac{a}{\pi_S \frac{\mu_H - \mu_L}{\mu_H}} - k(\gamma)\right) > 0. \tag{11}$$

We substitute the equations (3), (8) and (9) in (2) and compute the first order condition with respect to the probability of being informed π, thus obtaining implicitly the optimal investment in financial literacy:

Proposition 3 *When customers are not so much risk averse (i.e., $\rho < \hat{\rho}$) and the high pension plan is not too risky (i.e., $\hat{\rho} > 0$), they are willing to invest in financial literacy in order to have the chance to allocate their savings to high pension funds.*

Proof. See the appendix A.1. ■

In Appendix A.1, we carry out a comparative statics analysis in order to study how the investment in financial literacy is affected by the parameters. We consider only the case where the risk aversion coefficient is below the risk aversion's threshold (7): customers are not so much risk averse and prefer the high return-and-risk product. The optimization process throughout the life cycle is shaped by customer preferences, such as time discount rate and risk aversion. We find that the more customers are patient, which means a higher time discount factor, the more they put effort into financial literacy (see the equation (A.5)). We find that:

Proposition 4 *The investment in financial literacy depends on the risk aversion coefficient together with the probability of getting the signal. A higher risk aversion reduces the investment in financial literacy if the probability of getting the signal*

is low $\left(\pi < \frac{1}{2}\right)$*, while a higher risk aversion increases the investment in financial literacy if the probability of getting the signal is high enough* $\left(\pi > \frac{1}{2}\right)$.

Proof. See the appendix A.1. ■

The intuition of the Proposition 4 is that the acquisition of the signal is costly and it is riskier as the probability decreases.

We need to distinguish between the parameters that are outside the control of the regulator and those that could be directly regulated by the government, such as the transparency factor:

Proposition 5 *The higher the transparency the higher the probability of being informed.*

Proof. See the appendix A.1. ■

Let us remark that the individuals do not take into account the effect of the increased transparency on pension funds' management fees.

Assuming that the regulator introduces subsidies to investments in financial literacy, the cost $l(\pi, \gamma)$ is subsidized at a rate $\theta \in (0, 1]$. Individuals maximize the utility function (2) with respect to π, taking into account the reduction of the cost investing in financial literacy, but not the tax cost of the subsidy $\theta l(\pi, \gamma)$.[8] We find that:

Proposition 6 *The higher the rate of subsidy the higher the investment in financial literacy.*

Proof. See the appendix A.1. ■

[8]The budget constraint in period 0 becomes $y \geq c_0 + s + l(\pi, \gamma)(1 - \theta)$.

5 The regulation of pension funds

The government may intervene in the market of pension funds in different ways. In our setting, it is particularly important the intervention on the regulation of transparency requirements (Section 5.1).[9] A second policy we consider is the public provision of financial literacy (Section 5.2). Another important policy intervention is that government may introduce a public option, which is designed for individuals with low financial literacy or high risk aversion (Section 5.3).

5.1 Setting transparency standards

Transparency is a form of regulation of the pension fund industry. It may be complementary to financial literacy because it increases the probability of getting the signal and being informed. However, compliance with the provisions on transparency is costly and its costs are borne by pension funds and, then, translated on customers. There is a trade-off between costs and benefits of transparency.

The regulator is responsible for ensuring the welfare of the population. Social welfare is determined by summing the utility function of customers and the profit function of pension funds. Since the expected profit of pension funds is zero, the regulator has to maximize the intertemporal utility function (2) of customers with respect to transparency factor in order to maximize the social welfare.

Considering the case where the risk aversion coefficient is below the threshold (7), we substitute the equations (3), (8) and (9) in (2) and compute the first order

[9]For example, Markets in Financial Instruments Directive (MiFID) is a legislative framework enforced in the European Union, which regulates financial markets and rules transparency requirements. MiFID II entered into force in January 2018, replacing the previous directive in operation across the European Union since 2007. It aims at standardizing practices and increasing transparency, so as to improve protection for investors and restore confidence, particularly after the 2008 financial crisis.

condition with respect to the transparency factor γ, thus obtaining implicitly the optimal level of transparency (see the equation (A.17) in the appendix A.2).

5.2 The public provision of financial literacy

The investment in financial literacy depends on the costs of financial knowledge acquisition, which could be under the control of the regulator. The government may reduce the cost of financial literacy services, thus encouraging financial knowledge acquisition, by means of subsidies to investments in financial literacy.

The regulator maximizes the social welfare with respect to the rate of subsidy θ, including the tax cost of subsidy[10]:

$$\max_{\theta} \quad c_0 + \beta \left[E(c_1) - \frac{1}{2}\rho Var(c_1) \right] - \theta l(\pi, \gamma) \tag{12}$$

Considering the case where the risk aversion coefficient is below the threshold (7), we compute the first order condition with respect to θ, thus obtaining implicitly the optimal level of the rate of subsidy (see the equation (A.18) in the appendix A.2).

5.3 The public option

Transparency and subsides may improve the efficiency of the market of pension funds, but they do not overcome the adverse selection problem. Uninformed customers still do not get access to the high return-and-risk product and they might want it. We suggest a possible direction to address this issue, considering an alternative approach: the introduction of a public pension fund that competes with private ones in the market of pension funds. Introducing a public option is a form

[10] We do not take into account the marginal cost of public funds.

of structural regulation of pension funds. However, the public pension fund cannot yield the high return μ_H on pension savings, but it is conceived to provide an average return between μ_L and μ_H, and to charge an average management fee between ω_L and ω_H.[11] By choosing the public option, uninformed customers may have access to a higher expected return compared to the low return μ_L that otherwise they would get on average from low-skill pension funds. This public pension fund may be more aligned with their risk aversion coefficient and their preferences, although they cannot get the high return-and-risk product. customers that opt for the public pension fund do not have incentives to invest in financial literacy. This policy proposal may reduce the inefficiency of the market of pension funds arising from adverse selection, but it in turn may be affected by political agency problems. Indeed, the public pension fund may be benevolent or self-interested and tainted by corruption, depending on the quality of governance of public institutions. So again, there is a trade-off between costs and benefits of introducing a public option.

6 Conclusion

In order to explore the role of regulation and financial literacy in funded pension systems, we considered a theoretical model. Our theoretical predictions emphasize that it is not obvious that making the entire population financially literate is the best way to build up an adequate retirement income. customers may rationally choose not to invest in financial literacy in accordance with their optimization process. The policy mix between financial literacy and regulation by way of transparency has to be optimized, taking into account the arising trade-offs. On one hand, financial literacy

[11] We imagine that a public asset manager cannot be as good as private asset managers of high-skill pension funds.

has both costs, in terms of time and monetary resources, and benefits, in terms of better investment opportunities in line with risk aversion preferences of individuals. On the other, transparency increases the probability of being informed of individuals along with financial literacy, but it has costs borne by pension funds. The level of transparency established by the regulator affects the investment in financial literacy of individuals.

Moreover, asset allocation strategies of pension funds have to be consistent with the risk appetite of individuals. The investment in financial literacy depends on the risk aversion preferences along with the probability of being informed, which determines the ability of individuals of choosing the fund that optimizes their risk-return trade-off. We theoretically found that when the probability of being informed is low, a higher risk aversion may reduce the investment in financial literacy, while when the probability of being informed is higher, a higher risk aversion may increase the investment in financial literacy.

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A Appendix

A.1 The optimization problem of the individual: comparative statics

We consider only the case where the risk aversion coefficient is below the risk aversion's threshold (7) or the high pension plan is not too risky (see Proposition 1), because when it is above the risk aversion's threshold (and the high plan is too risky) the optimal investment in financial literacy is zero.

The first order condition with respect to the probability of being informed π is:

$$-l'_{\pi} + \beta s\Delta \left[1 - \frac{1}{2}\rho s\Delta(1-2\pi)\right] = 0 \tag{A.1}$$

In order that the first order condition is satisfied and thus we find an interior solution, the term in the square brackets in (A.1) has to be positive.[12] This is always satisfied when $\pi \geq \frac{1}{2}$. The term in the square brackets is increasing as π gets larger, hence $\pi = 0$ identifies the worst-case scenario. If $\pi = 0$, the term in the square brackets is positive when:

$$\rho < \frac{2}{s\Delta} \tag{A.2}$$

By comparing (7) and (A.2), the latter is always satisfied when the right-hand side of (7) is smaller than the right-hand side of (A.2), i.e., when:

$$\Delta^2 < [(1-\omega_H)^2\sigma_H^2 - (1-\omega_L)^2\sigma_L^2)] \tag{A.3}$$

It is a sufficient condition so that $\left[1 - \frac{1}{2}\rho s\Delta(1-2\pi)\right]$ is positive.

[12] The first term in (A.1) is always negative, because l'_{π} is positive by assumption.

We differentiate the equation (A.1) with respect to π and obtain:

$$f_\pi = -l''_{\pi^2} + \beta s^2 \Delta^2 \rho \tag{A.4}$$

In order to find a maximum, the second order condition requires that the equation (A.4) is negative.[13]

We determine the comparative statics results by computing the total differential of the first order condition (A.1). The sign of the partial derivative of the first order condition with respect to each parameter is what we are interested in when assessing the effect of a change in a parameter on π, because the equation (A.4) has to be negative and is preceded by a negative sign.

The impact of a change in β on π is calculated as:

$$\frac{\partial \pi}{\partial \beta} = -\frac{1}{f_\pi} s\Delta \left[1 - \frac{1}{2}\rho s\Delta(1-2\pi)\right] \tag{A.5}$$

which is positive, since the term in the square brackets has to be positive as stated above. Therefore, the investment in financial literacy increases with the time discount factor: the more customers are patient the more the probability of being informed.

The impact of a change in ρ on π is calculated as:

$$\frac{\partial \pi}{\partial \rho} = -\frac{1}{f_\pi} \left[-\frac{1}{2}\beta s^2 \Delta^2 (1-2\pi)\right] \tag{A.6}$$

which is positive when $\pi > \frac{1}{2}$, but it is negative when $\pi < \frac{1}{2}$. The investment in financial literacy depends on customers' risk aversion together with the probability

[13]The first term in (A.4) is always negative, because l''_{π^2} is positive by assumption.

of getting the signal: the more customers are risk averse, the more effort they put into financial literacy if the probability of getting the signal is high; vice versa, the more customers are risk averse, the less effort they put into financial literacy if the probability of getting the signal is not so high.

The impact of a change in γ on π is calculated as:

$$\frac{\partial \pi}{\partial \gamma} = -\frac{1}{f_\pi}\left[-l''_{\pi\gamma}\right] \tag{A.7}$$

which is positive, since the partial derivative in the square brackets is negative by assumption and preceded by a negative sign. A positive effect implies that the probability of being informed increases as the transparency factor increases.

The impact of a change in s on π is calculated as:

$$\frac{\partial \pi}{\partial s} = -\frac{1}{f_\pi}\beta\Delta[1-\rho s\Delta(1-2\pi)] \tag{A.8}$$

which is positive when $\pi \geq \frac{1}{2}$, but it is ambiguous when $\pi < \frac{1}{2}$. The investment in financial literacy depends on the amount saved, but it cannot be concluded that higher savings lead always to higher probability of being informed. Higher savings increase the investment in financial literacy if the probability of getting the signal is high enough.

The impact of a change μ_H on π is calculated as:

$$\frac{\partial \pi}{\partial \mu_H} = -\frac{1}{f_\pi}\beta s(1-\omega_H)[1-\rho s\Delta(1-2\pi)] \tag{A.9}$$

which is positive when $\pi \geq \frac{1}{2}$, but it is ambiguous when $\pi < \frac{1}{2}$. Therefore, when $\pi \geq \frac{1}{2}$, a higher average return of the high return-and-risk product is associated

with a higher investment in financial literacy.

The impact of a change in μ_L on π is calculated as:

$$\frac{\partial \pi}{\partial \mu_L} = -\frac{1}{f_\pi}\{-\beta s(1-\omega_L)[1-\rho s\Delta(1-2\pi)]\} \tag{A.10}$$

which is negative when $\pi \geq \frac{1}{2}$, but it is ambiguous when $\pi < \frac{1}{2}$. As opposed to the impact of a change in μ_H on π, when $\pi \geq \frac{1}{2}$, a higher average return of the low return-and-risk product is associated with a lower investment in financial literacy.

The impact of a change in ω_H on π is calculated as:

$$\frac{\partial \pi}{\partial \omega_H} = -\frac{1}{f_\pi}\{-\beta s\mu_H[1-\rho s\Delta(1-2\pi)]\} \tag{A.11}$$

which is negative when $\pi \geq \frac{1}{2}$, but it is ambiguous when $\pi < \frac{1}{2}$. Therefore, when $\pi \geq \frac{1}{2}$, a higher fee of the high return-and-risk fund is associated with a lower investment in financial literacy.

The impact of a change in ω_L on π is calculated as:

$$\frac{\partial \pi}{\partial \omega_L} = -\frac{1}{f_\pi}\beta s\mu_L[1-\rho s\Delta(1-2\pi)] \tag{A.12}$$

which is positive when $\pi \geq \frac{1}{2}$, but it is ambiguous when $\pi < \frac{1}{2}$. As opposed to the impact of a change in ω_H on π, when $\pi \geq \frac{1}{2}$, a higher fee of the low return-and-risk fund is associated with a higher investment in financial literacy.

Looking at the optimization problem of the individual in the case of public provision of financial literacy, the first order condition with respect to the probability

of being informed π is:

$$-l'_{\pi}(1-\theta) + \beta s\Delta \left[1 - \frac{1}{2}\rho s\Delta(1-2\pi)\right] = 0 \tag{A.13}$$

We differentiate the equation (A.13) with respect to π and obtain:

$$g_{\pi} = -l''_{\pi^2}(1-\theta) + \beta s^2\Delta^2\rho \tag{A.14}$$

In order to find a maximum, the second order condition requires that the equation (A.14) is negative. The impact of a change in θ on π is calculated as:

$$\frac{\partial\pi}{\partial\theta} = -\frac{1}{g_{\pi}}l'_{\pi} \tag{A.15}$$

which is positive, because the equation (A.14) has to be negative and is preceded by a negative sign, and the sign of l'_{π} is positive. Therefore, the higher the rate of subsidy the higher the investment in financial literacy.

A.2 The optimization problem of the government

We provide some additional notes and formulas about the optimization problem of the government with respect to the transparency standards and subsidies to investments in financial literacy. We consider only the case where the risk aversion coefficient is below the risk aversion's threshold (7).

The first order condition with respect to transparency factor γ is:[14]

$$-l'_{\gamma} - \beta s k'_{\gamma}\{\mu_L + \pi(\mu_H - \mu_L)[1 - \rho s \Delta(1-\pi)]\} + \\ +\beta \mu_H \frac{a}{\pi}\frac{\partial \pi}{\partial \gamma}[1 - \rho s \Delta(1-\pi)] = 0 \tag{A.16}$$

We differentiate the equation (A.17) with respect to γ and obtain:

$$f_{\gamma} = -l''_{\gamma^2} - l''_{\pi\gamma}\frac{\partial \pi}{\partial \gamma} - \beta s \Big\{ (\mu_H - \mu_L)\Big\{ k''_{\gamma^2}\pi[1 - \rho s \Delta(1-\pi)] \\ + k'_{\gamma}\frac{\partial \pi}{\partial \gamma}[1 - \rho s \Delta(1-\pi)] + k'_{\gamma}\frac{\partial \pi}{\partial \gamma}\pi \rho s \Delta \Big\} + \mu_L k''_{\gamma^2} \Big\} \\ + \beta \mu_H a \frac{1}{\pi}\Big\{ \frac{\partial \pi}{\partial \gamma}\Big\{ \Big(-\frac{1}{\pi}\frac{\partial \pi}{\partial \gamma} + \frac{\partial^2 \pi}{\partial \gamma \partial \pi}\Big)[1 - \rho s \Delta(1-\pi)] + \rho s \Delta \frac{\partial \pi}{\partial \gamma} \Big\} \\ + \frac{\partial^2 \pi}{\partial \gamma^2}[1 - \rho s \Delta(1-\pi)] \Big\} \tag{A.17}$$

In order to find a maximum, the second order condition requires that the equation (A.17) is negative.

The first order condition with respect to subsidy θ is:[15]

$$\frac{\partial \pi}{\partial \theta}\left\{ \frac{\beta \mu_H a}{\pi}[1 - \rho s \Delta(1-\pi)] - \theta \frac{\partial l(\pi, \gamma)}{\partial \pi} \right\} = 0 \tag{A.18}$$

[14]The regulator knows that what the individual chooses is equal to the market average at the equilibrium (all individuals are equal).

[15]The regulator knows that what the individual chooses is equal to the market average at the equilibrium (all individuals are equal).

We differentiate the equation (A.18) with respect to θ and obtain:

$$
\begin{aligned}
f_\theta = \frac{\partial \pi}{\partial \theta}\frac{\beta \mu_H a}{\pi}\Big\{\Big(\frac{\partial^2 \pi}{\partial \theta \partial \pi} - \frac{\partial \pi}{\partial \theta}\frac{1}{\pi}\Big)[1-\rho s \Delta(1-\pi)]\Big\} \\
+ \frac{\beta \mu_H a}{\pi}\Big\{\Big(\frac{\partial \pi}{\partial \theta}\Big)^2 \rho s \Delta + \frac{\partial^2 \pi}{\partial \theta^2}[1-\rho s \Delta(1-\pi)]\Big\} \\
- \frac{\partial \pi}{\partial \theta}\Big\{\frac{\partial^2 \pi}{\partial \theta \partial \pi}\theta\frac{\partial l(\pi,\gamma)}{\partial \pi} + \frac{\partial \pi}{\partial \theta}\theta\frac{\partial^2 l(\pi,\gamma)}{\partial \pi^2} + \frac{\partial l(\pi,\gamma)}{\partial \pi}\Big\} - \frac{\partial^2 \pi}{\partial \theta^2}\theta\frac{\partial l(\pi,\gamma)}{\partial \pi} \quad \text{(A.19)}
\end{aligned}
$$

In order to find a maximum, the second order condition requires that the equation (A.19) is negative.