Essays in Financial Economics

Lorenzo Pandolfi

TESI DOCTORAL UPF / ANY 2017

DIRECTOR DE LA TESI
Xavier Freixas
Departament d'Economia i Empresa

Universitat Pompeu Fabra Barcelona

To my parents, who made it possible. And to Ginevra, my safe harbor.

Acknowledgements

During the PhD I have accumulated a sizable debt of gratitude to many people whose help and support has been crucial in getting to this point and in writing this thesis. These few lines are just an attempt to repay part of my debt.

First and foremost, I wish to thank my supervisor, Xavier Freixas. Not only I owe him my gratitude for his patient guidance and for the precious assistance he provided but also, I sincerely thank him for the enormous encouragement I received from him during the thesis process and throughout my entire PhD.

My profound gratitude goes also to those faculty members at the Department of Economics and Business of the Universitat Pompeu Fabra who provided support at different stages of my research. In particular, I sincerely thank Javier Gil-Bazo, Filippo Ippolito, Jose Luis Peydro and Andrea Polo. A special thank goes to Jose Apesteguia, who contributed extensively to the third chapter of this thesis with all of his invaluable suggestions. I am very grateful to Marta Araque and Laura Agusti, whose constant help throughout these years has been simply amazing.

Among the others that contributed to this research, Marco Pagano deserves a special mention. Apart from the precious comments and suggestions I received from him about my work, I owe him the choice to undertake a PhD and a career as a researcher. And that's a considerable debt.

I am deeply grateful to my fellow PhD colleagues at UPF: Ana, Cristina, Francisco, Darren, Maria, Marta, Miguel, Niklas and Thomas. They made these years in Barcelona simply unforgettable and I am truly glad our paths crossed.

A priceless contribution to this work comes from Marco Nieddu and Tomas Williams, who also coauthored two of the three chapters in this thesis. They are really amazing coauthors, and even better friends.

Of course, I thank my parents, Aldo and Luciana - my first teachers and role models - as well as my brother Francesco and my sister Caterina that allowed me to get to this point by supporting me during my entire life with their unconditional love.

No words can express how grateful I am to Angelo, Betta, Bobo, Daria, Enzo, Laura, Marcello, Maria, Roberto, Ronnald and Valentina, for their friendship, for being part of my life since years and for all of the precious moments we have shared, and we will share in the future.

Last but obviously not least, I wish to thank Ginevra, my safe harbor, for bringing me joy every single day. As a small recompense for this priceless gift, I dedicate this thesis to her.

Abstract

This thesis consists of three chapters contributing to the broad field of financial economics. In the first chapter, I develop a theoretical model of bank bail-ins in order to analyze the effects of the implementation of such resolution mechanism on banks' behavior and on their financing capacity. The results from the model show that introducing bail-ins may have undesirable consequences in terms of social welfare when financial markets are characterized by moral hazard. Chapter 2 is devoted to an empirical investigation of the effects of informationless capital flows - coming from monthly rebalancings in the largest local-currency government-debt index for emerging countries - on the price and liquidity of sovereign bonds. I find capital flows to increase the returns on government bonds as well as their liquidity. Also, they spill over to the exchange rate market, with larger inflows prompting larger currency appreciations. Finally, the third and last chapter of this work contains an essay on financial literacy and asset evaluation. By designing and running a laboratory experiment, I find that increasing financial literacy - even with a short training - can substantially increase the value agents assign to a risky financial asset. This evidence is consistent with the results from a simple model of asset evaluation in presence of ambiguity averse agents.

Resumen

Esta tesis consiste de tres capítulos que pertenecen al campo de la economía financiera. En el primer capítulo, desarrollo un modelo teórico de *bail-in* bancario para analizar los efectos de la implementación de este nuevo mecanismo de resolución sobre el comportamiento de los bancos y sus capacidad de obtener fondos. Los resultados del modelo demuestran que la introducción de bail-ins puede repercutir negativamente sobre el bienestar social cuando los mercados financieros están caracterizados por un problema de *moral hazard*. El segundo capítulo es destinado a un estudio empírico de los efectos de los flujos internacionales de capitales - que resultan del rebalanceo mensual por parte del mayor índice de deuda soberana emitida en moneda local - sobre el precio y la liquidez de los bonos soberanos. Los resultados muestran que los flujos de capitales aumentan los retornos de los bonos del Estado, así como su liquidez. Ademas, afectan también el mercado de tipos de cambio, ya que flujos positivos llevan apreciaciones de las monedas locales. Finalmente, el tercer capítulo de esta tesis contiene un estudio sobre la alfabetización financiera y la evaluación de los activos financieros. A través de un experimento de laboratorio, muestro que aumentar el grado de alfabetización financiera - aunque sólo con un *teaching* de corta duración - puede aumentar significativamente el valor que los agentes asignan a productos financieros arriesgados. Esa evidencia es consistente con las predicciones de un simple modelo de evaluación de activos en presencia de agentes aversos a la ambigüedad.

Preface

The present thesis consists of three essays, each of them focusing on a specific topic in financial economics. The first chapter of this work - titled *The Dark Side of Bail-in* - is devoted to a theoretical analysis of bail-in. This resolution procedure for banks in distress - basically consisting in a debt-equity swap that allows to recapitalize banks from within, thus avoiding the use of taxpayers money - has become increasingly popular in recent years. In a model *à la* Holmstrom and Tirole (1997) with two investment stages, I explore the consequences of the implementation of bail-in policies on banks' incentives to monitor and on their financing capacity, and compare them with the effects of the adoption of alternative resolution mechanisms available to the regulator, *i.e.*, bailout and liquidation. The results from the model offer novel insights on the effects of bail-in policies. First, these policies can increase banks' cost of debt and reduce bankers' incentives to monitor their loan portfolio. Second, exactly as bailouts, also bail-ins can generate a dynamic inconsistency problem, since they are always optimal *ex-post* and this can lead to the breakdown of the credit market, *ex-ante*. Last, adding this new powerful policy tool to the set of resolution mechanisms available to policy-makers does not always increase social welfare: in some cases a bailout regime is more efficient. When this is the case governments should announce and pre-commit to alternative resolution mechanisms or, if possible, to a mixed-strategy that randomizes over bail-ins, bailouts and liquidations. The optimal mixed-strategy adopted by the government depends on the magnitude of the cost of transferring money from the public to the private sector and always involves a positive probability of bail-in.

In chapter 2 - *Capital Flows and Sovereign Debt Markets: evidence from index rebalancings*, coauthored with Tomas Williams from Washington University - we analyze how government bond prices and liquidity are affected by capital flows to the sovereign debt market. We also explore whether these flows spill over to the exchange rate market. The main contribution of this work is the measure of informationless capital flows that we construct in order to tackle identification concerns coming from the obvious endogeneity between capital flows and sovereign bonds. In particular, we exploit monthly rebalancings in the largest local-currency government-debt index for emerging countries together with a peculiar feature of this index: the relative importance - that is, the *benchmark weight* - of each country cannot exceed 10% of the index at the beginning of each month. This feature induces monthly near-mechanical adjustments that we exploit to construct a measure of informationless flows coming from the rebalancings (FIR). We find that FIR is positively associated with the returns on government bonds and with the depth of the sovereign debt market after the rebalancings. These capital flows also impact the exchange rate market, larger inflows (outflows) being associated to greater currency appreciation (depreciation).

Finally, the focus of the work presented in Chapter 3 - *Financial Literacy and Asset Evaluation: evidence from a laboratory experiment*, coauthored with Marco Nieddu from UPF - is on the causal impact of financial literacy on individuals' evaluation of financial assets. This paper contributes to a vast body of literature that analyzes the impact of financial literacy on the financial behavior of economic agents. Overcoming the possible endogeneity between financial literacy and financial behavior is however challenging and the evidence in the literature lacks causal evidence. To partially fill this gap, we design and run a laboratory experiment where participants are asked to evaluate a risky lottery - that is framed either as a simple coin toss, or as a financial security - after being randomly exposed to a *teaching* treatment that exogenously increases their degree of financial sophistication. As a result of this double randomization, participants are randomly split into four different groups and, by comparing the average certainty equivalent in the groups, we get the following key results: first, we find that the financial framing reduces the value assigned to the risky lottery; then, we find that the *teaching* treatment - that is, the exogenous increase in financial literacy - enhances the understanding of the lottery's fundamentals and increases participants' certainty equivalents. These findings are consistent with the predictions from a model of asset evaluation in presence of ambiguity averse agents.

Contents

List of Figures

List of Tables

Chapter 1

THE DARK SIDE OF BAIL-IN

1.1. Introduction

In early 2010, the head of Credit Suisse, Paul Calello, and its former chief risk officer, Wilson Ervin, published a very well-known article on *The Economist* proposing a new resolution mechanism for banks in distress: the *bail-in*. This mechanism basically consists in a debt-equity swap imposed by the regulator that allows to recapitalize the bank from within by converting part of his debt into equity.[1] Since then, the concept of bail-in has become increasingly relevant and many economists and policy-makers throughout the world highlighted the importance of this new policy tool. Differently from bailouts, it would allow governments to rescue systemically important financial institutions using their internal resources instead of taxpayers' money while at the same time avoiding their inefficient liquidation, thus mitigating the too-big-to-fail problem. Less attention, however, has been put on the possible costs associated to bail-ins, mainly driven by the increase in the cost of debt that is likely to follow the implementation of

[1]Hence, a bail-in is a statutory power that enables the regulator to restore solvency of financial institutions in distress, reducing its financial leverage. It substantially differs from contingent convertibles, *i.e.* CoCos, that are fixed-income instruments whose conversion into equity in the occurrence of a specified trigger event is already envisaged in the debt contract, together with the conversion rate.

such policies, due to the losses imposed on banks' debtors in the conversion.

The aim of this paper is exactly to shed light on the *dark side* of bail-ins - that is, on the possible inefficiencies these can generate - and to compare bail-ins with the alternative resolution mechanisms available to policy-makers. Using a model *à la* Holmstrom and Tirole (1997) with two investment stages, I explore how bail-in policies affect the financing capacity of banks and show that they can determine an increase in the cost of debt that is, in turn, likely to affect bank behavior given the presence of moral hazard. Indeed, if investors expecting a bail-in increase the required return on debt, banks' profits decrease possibly reducing the incentives to monitor. In other words, bail-ins may exacerbate moral hazard instead of mitigating it. In some cases, this situation leads to a credit market freeze.

This result is due to a dynamic inconsistency problem. Once implemented, bail-ins become the first-best resolution mechanism for regulators when dealing with large banks facing distress events. Therefore, *ex-ante*, agents anticipate that the government will always bail in banks in distress and in some cases, there is no incentive compatible rate of return that the banker can promise to investors to compensate them for the losses they would suffer in a bail-in. Interestingly, this result is not affected either by the degree of competition among banks or by their capital structure.

Although relevant, this result does not imply, per se, that the introduction of bail-ins generates a loss for society. It could also be that the credit market freezes in situations where bailouts would have led to an even less efficient equilibrium. So, I compare the bail-in equilibrium with the one that would emerge in a regime where bailouts are the only policy instrument available to policy-makers to save banks. In such a *pre-bail-in* world, the main cost for society comes from the implicit guarantee of bailouts provided by the government that can lower bankers' incentives to monitor their investments, thus increasing the risk of bankruptcies. The model shows that this cost does not always exceeds the one associated to bail-ins. There are cases in which bailouts would have been more efficient than bail-ins, avoiding the credit market freeze and providing the right incentives for bankers to monitor. When this is the case, and bail-ins are available, the regulator can restore efficiency by announcing and credibly pre-committing to alternative resolution mechanisms. In equilibrium, the welfare-maximizing strategy of the regulator is a mixed strategy that depends on the shadow cost of bailouts, that is, on the cost of transferring money from the public to the private sector.

The results of the model provide novel insights on the effects of bail-in policies, thus contributing to the complex debate on the optimal policy regulators should adopt when dealing with large financial institutions in distress. According to this paper, bail-ins are indeed an *ex-post* efficient solution and a precious instrument for policy-makers but they are not a *panacea* for the too-big-to-fail mechanism since they can generate an adverse reaction in the credit market, *ex-ante*. When announcing bail-in policies regulators should take into account that bail-ins are likely to increase the cost of debt for banks and that this can, in turn, distort banks' incentives. The rest of the paper is organized as follows: section 1.2 summarizes the regulatory context and the literature on bail-ins; section 1.3 presents the equilibrium of the model, a comparison with a bailout regime and extends the analysis to the cases of bank competition and equity issuance; finally, section 1.4 concludes.

1.2. Regulatory Context and Literature Review

Since their theorization, several countries already announced the introduction of bail-in policies. In the US, for instance, the bail-in process was imbedded in Title II of the Dodd-Frank Act, that is, the Orderly Liquidation Authority. Under Title II, the Federal Deposit Insurance Company (FDIC) is appointed receiver of the defaulting financial company and has up to five years to efficiently liquidate it, thus preserving the value of the assets. A similar mechanism is envisaged within the Single Point Of Entry (SPOE) strategy for resolving systematically important financial institutions.[2] Formally adopted in December 2013, the SPOE approach aims to impose market accountability and to maintain financial stability, imposing losses on both shareholders and debtholders. In this case, the bail-in is meant to reduce tax payers' losses and the social cost of the resolution and the bank is treated as a gone concern. Therefore the SPOE is a *closed bank* bail-in process,

[2] A detailed description of this resolution approach is provided in a joint paper published by the Federal Deposit Insurance Company and the Bank of England in 2012.

used to minimize systemic disruption in a liquidation more than to rescue the troubled financial institution.

In late 2013, also the European Union reached political agreement on the Bank Resolution and Recovery Directive (BRRD) - that is, Directive 2014/59/EU - which establishes the legislative basis for bail-in within the EU. Differently from the US, the European approach considers also the possibility of using the bail-in as an *open bank* resolution process to efficiently recapitalize the bank in order to keep it as a going concern. In this case, according to the BRRD, bail-ins can imply either the cancellation or the dilution of existing shares and bailed-in debtholders are entitled to shares of the bank.

Hence bail-ins can take different forms and their optimal design remains a subject of ongoing discussion for policy-makers. However, a few countries already experienced a bail-in event. An exhaustive summary of such cases is presented by Schäfer et al. (2016) in their analysis of the effects of bail-in events on creditors' expectations. One of the first European countries to experience such an event was Denmark. On the 6^{th} of February 2011, the Danish authorities decided to bail in senior debtholders and unsecured depositors of the Danish Institute Amagerbanken, imposing them an haircut of 41%. Similarly, the Dutch Bank SNS Reaal was bailed in at the beginning of 2013, when the bank was nationalized and junior bondholders lost their entire investment. Undoubtedly, the most famous case of bail-in in the eurozone was Cyprus where, on the 28th of April 2013, the Bank of Cyprus converted 47.5% of uninsured deposits exceeding 100,000 euros into equity. In August 2014, also the Portuguese Banco Espírito Santo was bailed in, with junior debtholders bearing some of its losses. By looking at the behavior of bank CDS spreads and stock prices before and after these bail-in events, as well as around the date of the introduction of the BRRD in Europe, Schäfer et al. (2016) find empirical evidence of a negative impact of bail-ins on future bank returns - especially for systemically important banks and for banks belonging to the GIIPS countries - due to the increase in their funding costs that comes from the reduction in creditors' bailout expectations.

From a purely theoretical point of view, the topic of statutory bail-in is still relatively unexplored and the related literature has been mainly produced by policy makers and institutions rather than academics. Most of this literature seems to agree on the effectiveness of bail-in as the optimal resolution mechanism when dealing with failing banks. In a 2009 IMF position note, for instance, Landier and Ueda (2009) show that, as long as debt renegotiation is feasible, a debt-equity swap can lower a bank's probability of default without any government intervention. Relatedly, Rutledge et al. (2012), in a 2012 IMF discussion note, claim that "[...] bail-in could mitigate the systemic risks associated with disorderly liquidations, reduce deleveraging pressures, and preserve asset values that might otherwise be lost in a liquidation." (p.3). The Association for Financial Markets in Europe (AFME) published a paper in 2010 supporting the necessity of giving national regulators the authority to quickly recapitalize banks through debt-equity swaps so as to avoid their inefficient liquidation, thus averting the risk of fire-sales and bank runs. A resolution procedure that requires a minimum haircut on uninsured creditors is essential to promote financial stability also according to Calomiris (2011), while Huertas (2013) emphasizes that bail-ins are superior to bailouts since they allow to reduce the negative impact of banks' insolvency on the economy without imposing any cost on taxpayers. More recently, Chari and Kehoe (2016) show that enabling the government to impose losses on unsecured debtholders reduces the inefficiencies implied by bailouts' subsidies.[3] In contrast to this tendency in favor of bail-ins, few authors draw attention to the potential disadvantages implied by their implementation. A critical evaluation of such resolution mechanism is provided by Avgouleas and Goodhart (2014), who claim that bail-ins might not be sufficient to reduce the threat of a systemic bank crisis, during which bailouts should be preferred. Also Anderson (2011) argues that bail-ins need to be carefully designed to be truly effective, and a critical issue that still needs to be addressed is the allocation of ownership and control rights among the agents involved in the recapitalization process.[4]

Whilst the literature on bail-ins is relatively scarce, the one on bailouts is much more vast and divided. On the one hand, bailouts can incentivize bankers' to un-

[3]Actually, the authors show that such resolution procedures are more efficient than bailouts, but do not reduce the incentives for firms to be inefficiently large. Because of this, the regulator should tax size and put a limit on firms' debt-to-value ratio.

[4]Other recent works on bail-ins are the ones by Bernard et al. (2017) that investigate the interactions between bail-ins and interbank networks, and the one by Mendicino et al. (2017) who focus on bail-ins and banks' total loss absorbing capacity in presence of moral hazard.

dertake risk (Repullo (2005)) and diminish the incentives of uninsured debtholders to monitor the behavior of the bank (Kaufman (1991)), thus leading to excessive risk-taking. They can also increase systemic risks by providing banks the incentives to pick correlated risks in order to maximize bailout gains in case of a systemic collapse of the banking system (Farhi and Tirole (2012)). On the other hand, bailouts can avert contagion risks by reducing the likelihood of fire sales (Acharya and Yorulmazer (2008)), and can also mitigate moral hazard.[5] Finally, in order to minimize the losses implied by the liquidation of large financial institutions while at the same time mitigating the moral hazard problem associated with bailouts, it might be optimal for policy-makers to adopt a mixed strategy according to which banks are bailed out with some positive probability. This concept, introduced by Freixas (2000), is known as *constructive ambiguity*.

Hence, a controversial literature has built up on bailouts whilst a relatively scarce theoretical literature has been dealing with bail-ins. Moreover, very few authors focused on the comparison between these two resolution mechanisms from a social perspective. Therefore, the main motivation of this paper is to shed light on the effects of bail-in policies - and in particular of *open bank* bail-ins - on bank behavior and to compare them with alternative resolution mechanisms, especially bailouts, in presence of moral hazard.

1.3. The Model

1.3.1. Model Setup

I consider a three-date zero-interest-rate economy populated by risk-neutral agents that do not discount the future. In this economy there is a representative bank owned by one agent who is also its manager, a number of entrepreneurs endowed with risky projects and competing for bank loans and a multitude of competitive investors.[6]

At time 0, the manager of the bank has the possibility to make a unit-sized

[5] See for instance Cordella and Yeyati (2003), Diamond and Rajan (2005) and Ratnovski and Dell'Ariccia (2012).

[6] Since it's the same agent, I use interchangeably manager and banker in the rest of the paper.

loan to an entrepreneur for a project that yields either x, in case of success, or 0. The probability of success of the project depends on the effort that the manager of the bank exerts in monitoring the entrepreneur. Conditional on exerting effort, the probability of success is p_H, otherwise it is $p_L < p_H$. and the banker gets a private benefit equal to B that can be interpreted as the monitoring cost he saves. The bank has no capital in t_0 and, in order to invest in the project, the banker has to borrow 1 unit of money from competitive outside investors through standard debt contracts, promising them a repayment equal to R_1 in t_1.

In t_1 the outcome of the project is publicly observed. If it succeeds, the bank is able to extract all the rents from the project financed - thus getting x net of the repayment promised to debtholders - and the game ends.[7] When the project fails, instead, the bank gets 0 and cannot repay outside investors. In this case, the government can decide whether to liquidate the bank, paying the liquidation value L to debtholders, or to save it either through a bail-in or through a bailout, thus allowing the bank to operate in a second investment stage. With the former, the government simply converts the debt of the bank into equity. Outside investors that lent money in t_0 are entitled to a fraction $1 - \alpha$ of the bank's future profits while the remaining fraction α stays to the banker. Regardless of the size of α, he keeps running the bank. Finally, the size of the α is chosen by the government in t_1. It is worth discussing these assumptions about bail-ins. Assuming that the manager keeps running the bank after the bail-in and that he is not completely wiped out during the recapitalization might appear at odds with reality. In fact, the top executives of a bank are usually replaced during a bail-in but the business plan of the bank, its long-term investments and its policy, are not likely to change overnight. Moreover, assuming that the bank manager is still in charge simply implies that he acts in the interest of former shareholders rather than in that of bailed-in debtholders. These are indeed likely to be too unsophisticated and dispersed to exercise some control on the bank immediately after the recapitalization. The assumption that the owner of the bank is entitled to a fraction α of the share, so being diluted but not completely wiped out, finds support in the de-

[7] For simplicity, I assume the bank has enough market power to get the entire return from the project as a repayment for the loan he makes to the entrepreneur. Removing this assumption, and considering a repayment to the banker equal to $x\prime < x$ does not change the main predictions of the model.

sign of bail-ins proposed in the BRRD. In line with the latter, it is appropriate for existing shares not to be entirely cancelled or transferred but to be diluted through the conversion of debt into equity when this helps keeping the value of the bank.

If instead the government opts for a bailout in order to rescue the financial institution, it directly injects capital into the bank. Then, with the resources transferred by the government, the manager can pay back R_1 to debtholders and operate in the second investment stage. When a bailout occurs, the banker keeps running the bank and being the only equityholder, so he is entitled to all the profits coming from the second project.[8] Transferring money from the public to the private sector is costly: for each unit of money given to the bank, the government has to raise $1 + \lambda$ units of money from taxpayers. This λ can be easily interpreted as the cost implied by distortionary taxation and depends on some country-specific and macroeconomic conditions. For instance, it will be higher in countries whose economies are weaker as well as during a crisis, when it becomes more costly for a government to find and transfer enough resources to save a systemically important bank.

In t_2, if the government saved the bank, the manager can make another investment - that is, he lends money to another entrepreneur - that yields x in case of success and 0 in case of failure. The second investment stage is also characterized by moral hazard and the probability of success can be either p_L or p_H depending on whether the bank manager monitors the entrepreneur or not. If not, he gets a private benefit again equal to B. As in the first investment stage, the banker has to borrow one unit of money from outside competitive investors, promising them a return equal R_2 to be paid once the outcome of the project is publicly observable.

Finally, in t_3, the outcome of the second project is observed. If it fails, the bank goes bankrupt and the liquidation value is 0. If the project succeeds, the bank pays back R_2 to debtholders that lent in t_2 and:

- if a bailout occurred in t_1, $x - R_2$ goes to the manager of the bank;

[8] In reality, also bailouts should imply the dilution of existing shares. For simplicity, however, I assume this is not the case, so as to model the idea that the dilution of shares in a bailout is negligible compared to the one implied by a bail-in. As regards the fact that the manager is still running the bank after the bailout, it simply reflects the idea that shareholders of the bailed out institution are still the ones in whose interest the manager operates.

- if a bail-in occurred in t_1, $\alpha(x-R_2)$ goes to the manager and $(1-\alpha)(x-R_2)$ to bailed-in debtholders; that is, to outside investors that lent in t_0.

The two-stage structure of the game is related to the setup by Mailath and Mester (1994), as it allows to model the trade-off regulators face between ex-post and ex-ante optimality of the resolution mechanism they adopt when dealing with banks and therefore to compare the equilibrium outcomes with and without pre-commitment. A graphical representation of the model setup is provided in Figure 1.1, where p_i can be either p_H or p_L depending on whether the manager monitors or not.

As regards the parameters of the model, I make the following assumptions:

Assumption 1 *The investment that the banker can undertake in both t_0 and t_2 has positive net present value if the manager exerts effort and monitors the entrepreneur and negative net present value otherwise. Moreover, the net present value of the project, when the banker exerts effort, is larger than the liquidation value of the bank, L, which is in turn lower than 1. Finally, the net present value of the project, even when the manager monitors the entrepreneur, is lower than the pledged repayment to debtholders, 1.*[9] *Formally:*

$$1 > \underbrace{p_H x - 1}_{\overline{NPV}} > L > 0 > \underbrace{p_L x - 1}_{\underline{NPV}}. \tag{1.1}$$

It follows that, from a social perspective, saving the bank is efficient only when the banker is expected to exert effort in the second investment stage.[10]

Assumption 2 *The degree of moral hazard is low enough to allow the manager to get financing at the competitive interest rate in a one-shot version of the model with a single investment stage. If not fulfilled, the project would not be financed in either investment stage. So:*

$$\frac{B}{\Delta p} \leqslant x - \frac{1}{p_H}. \tag{1.2}$$

[9] This ensures that, in case of failure at time 1, debtholders have no incentives to lend an additional unit of money to the bank in the second investment stage.

[10] This is the typical debt overhang problem: debtholders anticipate that, out of the $p_H x$, 1 must go to repay past debtors. So, in expected value, debtholders would not get repaid entirely (as $p_H x - 1 < 1$) even if in the good state of nature they are paid $x - 1$ (all the bank's surplus).

Assumption 3 *The parameters of the model are such that:*

$$\overline{NPV} < -\frac{\underline{NPV}}{1-p_L}, \tag{1.3}$$

where $\overline{NPV} = p_H x - 1$ *and* $\underline{NPV} = p_L x - 1$. *This assumption on the parameters of the model ensures debtholders have no incentives to lend to the bank in* t_0 *if the banker is not going to monitor the first project. If violated, the profits from the second investment stage would be so high that bail-ins could generate a perverse and counterintuitive equilibrium in which debtholders would not care about the first investment stage given that, in case of failure of the latter, they would get very high profits in the second investment stage after the government bails in the bank.*

1.3.2. The equilibrium

In this subsection, I characterize the Subgame Perfect Nash Equilibrium of the game. It will consist in a strategy profile that represents a Nash equilibrium of every subgame. To illustrate this equilibrium, I proceed by backward induction starting from the second investment stage.

The second investment stage

The second investment stage takes place only if the bank was saved, either through a bail-in or a bailout, after the failure of the first project financed by the banker. In this case, he has the opportunity to invest again in a project - that is, to lend money to another entrepreneur - of size 1 yielding either x or 0 in one period. To invest in this project the manager has to borrow money from outside competitive investors, promising them a gross return equal to R_2.

Outside investors are willing to lend only if their participation constraint is satisfied; that is, if

$$p_i \min\{x, R_2\} \geqslant 1, \quad \text{with } i = \{H, L\}.$$

Since $p_L x < 1$, by Assumption 1, investors lend to the bank only if the manager is going to exert effort, monitoring the entrepreneur.

It follows that, in the equilibrium of the second investment stage, the incentive constraint of the banker has also to be satisfied. Differently from the participation constraint of investors, this incentive constraint is conditional on the choice made by the government when saving the bank. Indeed, if the government saved the bank through a bailout in t_1, the manager remains the sole owner of the bank, entitled to the entire future profits. Therefore, his incentive constraint is:

$$p_H(x - R_2) \geqslant p_L(x - R_2) + B$$

that can be rewritten as

$$R_2 \leqslant x - \frac{B}{\Delta p} \equiv \hat{R}_2^{BO}, \tag{1.4}$$

where $\Delta p = p_H - p_L$.

If instead the bank was rescued through a bail-in in t_1, the banker is only entitled to a fraction α of bank future profits and his incentive constraints is:

$$\alpha p_H(x - R_2) \geqslant \alpha p_L(x - R_2) + B,$$

that can be rewritten as

$$R_2 \leqslant x - \frac{B}{\alpha \Delta p} \equiv \hat{R}_2^{BI}. \tag{1.5}$$

As one can notice, $\hat{R}_2^{BI} \leqslant \hat{R}_2^{BO}$ since the maximum repayment that can be promised to debtholders without violating manager's incentive constraint is lower in case of bail-in than in case of bailout. This happens because a bail-in reduces the share of future profits that goes to the manager of the bank, thus reducing his incentives to monitor. Hence, bailouts mitigate moral hazard in the second investment stage.

Competition among investors implies that the equilibrium gross return has to satisfy their participation constraint as equality. So:

$$p_H \min\{x, R_2\} = 1 \Rightarrow R_2 = \frac{1}{p_H} \tag{1.6}$$

that can be used in both (1.4) and (1.5) in order to obtain the relevant conditions for the existence of an equilibrium with investment in t_2, following either a bailout or a bail-in. These two conditions are:

$$R_2 = \frac{1}{p_H} \leqslant x - \frac{B}{\Delta p} \equiv \hat{R}_2^{BO} \tag{1.7}$$

in case the bank was saved through a bailout, and

$$R_2 = \frac{1}{p_H} \leqslant x - \frac{B}{\alpha\Delta p} \equiv \hat{R}_2^{BI} \tag{1.8}$$

in case the bank was saved through a bail-in.

Assumption 2 guarantees that (1.7) is always satisfied. The manager of the bank is always able to raise funds in the second investment stage and to invest in the project after a bailout. Since $\hat{R}_2^{BI} = \hat{R}_2^{BO}$ when $\alpha = 1$, then also (1.8) is always satisfied for $\alpha = 1$. Given that $\hat{R}_2^{BI}$ is monotonically increasing in α, it is possible to identify a minimum level of α, strictly lower than 1, the manager has to be entitled to in order not to violate his incentive constraint. This minimum level of α - that I define as $\underline{\alpha}$ - is the one that satisfies (1.8) as equality. Hence:

$$\frac{1}{p_H} = x - \frac{B}{\underline{\alpha}\Delta p} \Rightarrow \underline{\alpha} = \frac{Bp_H}{\Delta p\overline{NPV}}$$

where $\overline{NPV} = p_H x - 1$. By assumption 2, $\underline{\alpha}$ is strictly positive and lower than 1.

Lemma 1 *The manager is always able to get financing at the competitive interest rate in the second investment stage if the government saves the bank either through a bailout or through a bail-in that leaves him a fraction of the shares of the bank no lower than* $\underline{\alpha}$.

Figure 1.2 provides a graphical representation of the equilibrium in the second investment stage in the space $[\alpha, R_2]$. As one can notice, the competitive interest rate, that is equal to $\frac{1}{p_H}$, is always smaller than $\hat{R}_2^{BO}$, whilst $\hat{R}_2^{BI}$ is an increasing and concave function of α, and it is lower than the competitive interest rate only for $\alpha < \underline{\alpha}$.

The choice of the government

In t_1, if the first project failed, the government has to decide whether to liquidate the bank or to save it, either trough a bailout or through a bail-in. When making its choice, the government anticipates that, in case of bail-in, the manager is going to monitor in the successive period only when he is entitled to a fraction of bank shares no lower than $\underline{\alpha}$. Therefore, it is never optimal to bail in the bank leaving to him less than $\underline{\alpha}$ of bank shares since the bank would not be able to raise funds in the second investment stage and will have to close down anyway. It follows that we can restrict the equilibrium strategies available to the government to: bailout, bail-in with $\alpha \in [\underline{\alpha}, 1]$ and liquidation.

Of course, the three alternative strategies lead to different payoffs for the agents in this economy. In particular:

- When the government liquidates the distressed bank, only outside investors that lent money in the first investment stage obtain a positive payoff, which is equal to the liquidation value of the bank.
- If the government opts for a bailout, debtholders get the promised interest rate R_1 from the government that, in turn, incurs in a cost equal to $(1+\lambda)R_1$ because of the cost of transferring money from the public to the private sector. The manager, that is the only initial equityholder of the bank, is entitled to the expected value of the profits coming from the second investment stage, which is equal to the net present value of the project conditional on monitoring.
- If the government bails in the bank, it saves the cost of transferring money from the public to the private sector and bank's expected profits are shared between the manager and initial debtholders.

Table 1.1 summarizes the payoffs that all agents get at time 2, depending on the choice of the government.[11]

Since the government aims to maximize social welfare, that is, the sum of the payoffs of the agents, the socially optimal choice in t_1 is to rescue the distressed bank through a bail-in. Indeed, the social expected payoff following a bail-in is exactly equal to $\overline{NPV}$ and exceeds by λR_1 the expected social payoff following a

[11] In the table, G is the government, E is the manager - that is, the sole initial equityholder of the bank - and D the initial debtholders, that become shareholders in case of a bail-in. It is worth recalling that α has to be in the interval $[\underline{\alpha}, 1]$.

Table 1.1: Payoffs from government's choice

	D	E	G
Bail-in	$(1-\alpha)\,\overline{NPV}$	$\alpha\overline{NPV}$	0
Bailout	R_1	$\overline{NPV}$	$-(1+\lambda)R_1$
Liquidation	L	0	0

bailout. A bail-in is also preferred to liquidation since $\overline{NPV} > L$, by Assumption 1.

Finally, bailout dominates liquidation if $\lambda R_1 < \overline{NPV} - L$, that is if the cost of transferring money from the public to the private sector does not exceed the additional payoff coming from rescuing the bank instead of liquidating it. On the contrary, when $\lambda R_1 > \overline{NPV} - L$, liquidating the bank dominates bailout. Intuitively, when the liquidation value and the social cost of bailouts are relatively high, liquidation is preferred, and *vice versa*.

Lemma 2 *In case of bank failure, a bail-in with any $\alpha \in [\underline{\alpha}, 1]$ is the first-best policy. The second-best policy is a bailout if the cost of distortionary taxes and the liquidation value of the bank are low, and liquidation otherwise.*

The first investment stage

Having defined the equilibrium strategies following the failure of the first project, one can solve for the equilibrium in the first investment stage. In t_0, outside investors anticipate that, if the project fails, the government will bail in the bank and that they will be entitled to a fraction $1-\alpha$ of the profits coming from the second investment, namely $\overline{NPV}$. This gives the following participation constraint:

$$p_i \min\{x, R_1\} + (1-p_i)\,(1-E[\alpha])\,\overline{NPV} \geqslant 1, \text{ with } i = \{H, L\}. \tag{1.9}$$

Assumption 3 guarantees that such constraint can be satisfied only for $p_i = p_H$ (see Proof 1 in Appendix 1.A). Therefore, if debtholders expect the manager not to monitor in the first investment stage, they do not lend to the bank. Finally, on the equilibrium path beliefs have to be correct, and therefore $E[\alpha]$ is equal to α.

Hence, an equilibrium in the first investment stage in which the bank is able to raise funds and to invest in the project, given that the manager has the right incentives to monitor the entrepreneur, will feature a gross return R_1 that satisfies both the participation constraint of outside investors for $p_i = p_H$ and the incentive constraint of the banker, which is:

$$p_H(x - R_1) + \alpha\,(1 - p_H)\,p_H(x - R_2) \geqslant p_L(x - R_1) + \alpha\,(1 - p_L)\,p_H(x - R_2) + B.$$

Replacing the gross return to be promised to future investors, namely R_2, with the competitive one, $\frac{1}{p_H}$, the latter can be written as:

$$R_1 \leqslant x - \frac{B}{\Delta p} - \alpha\overline{NPV} \equiv \hat{R}_1^{BI}. \tag{1.10}$$

Competition in the credit market implies that the equilibrium gross return required by investors has to satisfy their participation constraint as equality, also in t_0. Therefore:

$$R_1^{BI} = \frac{1}{p_H} - \frac{(1 - p_H)\,(1 - \alpha)\,\overline{NPV}}{p_H}.$$

The condition ensuring that the bank is able to raise funds in the first investment stage is:

$$R_1^{BI} = \frac{1}{p_H} - \frac{(1 - p_H)\,(1 - \alpha)\,\overline{NPV}}{p_H} \leqslant x - \frac{B}{\Delta p} - \alpha\overline{NPV} \equiv \hat{R}_1^{BI}$$

which can be again expressed as a condition on α, that is on the share of bank's ownership that remains to the manager in a bail-in:

$$\alpha \leqslant (2 - p_H) - \frac{p_H B}{\overline{NPV}\Delta p} \equiv \bar{\alpha}. \tag{1.11}$$

Intuitively, $\bar{\alpha}$ is the the maximum fraction of bank shares that the manager should expect to receive in case of a bail-in without distorting his incentives to monitor in the first investment period. When α is higher than $\bar{\alpha}$, the manager has no incentive to monitor in the first investment period because he anticipates that, even if project fails, he will be able to invest again in the second investment period and will be entitled to a relatively high fraction of future profits. But then, investors in the first period will not fund the bank.

Lemma 3 *If a bail-in policy is implemented, in the first investment period, on the equilibrium path, the manager of the bank is able to get financing at the competitive interest rate and monitors the project only if he is expected to receive a fraction α of bank shares lower or equal than $\bar{\alpha}$ in a bail-in.*

The Subgame Perfect Equilibrium

When the first investment fails, the optimal choice of the government is to bail in the bank, leaving at least a fraction $\underline{\alpha}$ of bank shares to the manager. Then, in the first investment stage, competitive investors anticipate this and lend to the bank only if they are promised a return in case of success equal to R_1^{BI} and the manager is expected to monitor the first investment, which is the case only if he receives a fraction of bank shares no higher than $\bar{\alpha}$ in a bail-in. Intuitively, this happens because if the shares of the manager - that is the shares of the initial shareholders of the bank - are excessively diluted in a bail-in, he will not have enough incentives to behave in the future but, at the same time, if his shares are not diluted enough, he has no incentives to behave in the first investment stage.

So, in order to have a Subgame Perfect Nash equilibrium in which investors lend to the bank in t_0, and the manager monitors the first project, the set $[\underline{\alpha}, \bar{\alpha}]$ has to be not empty. When this is not the case outside investors anticipate that the manager is not going to monitor either in the first investment stage or in the second one.

A SPNE in which the bank gets financing in both the investment stages and the government opts for a bail-in in case of failure of the first project exists only if $\underline{\alpha} \leqslant \bar{\alpha}$, which is the case only if:

$$\frac{B}{\Delta p} \leqslant \left(x - \frac{1}{p_H}\right)\left(1 - \frac{p_H}{2}\right) \equiv \Psi_{BI}. \tag{1.12}$$

Hence, in equilibrium two different cases may emerge:

- if (1.12) holds, the bank gets financing in both the investment stages, the manager monitors both the projects and, in case of failure of the first project, the government rescues the bank through a bail-in and chooses any α in $[\underline{\alpha}, \bar{\alpha}]$, that is perfectly anticipated in t_0.

- if (1.12) does not hold, the bank is not able to raise funds in the first investment stage and so the game ends in t_0 with no project financed. This happens because investors in t_0 anticipate that the government will bail in the bank in case of failure and will give the manager a fraction $\alpha \geqslant \bar{\alpha}$ of future profits to make sure he will monitor in the second project but then he has no incentives to monitor in the first investment stage.

Proposition 1 *In the Subgame Perfect Nash Equilibrium of the game, the bank is able to get financing in both the investment stages only if the moral hazard problem is not too severe, i.e., when* $\frac{B}{\Delta p} \leqslant \Psi_{BI}$. *If instead* $\frac{B}{\Delta p} > \Psi_{BI}$, *the credit market collapses.*

1.3.3. A comparison with the *pre-bail-in* world

So far, I showed that bail-ins can lead to the freezing of the credit market. However, the relevant question for policy-makers is: was the world better before bail-ins? To answer this question, I present the equilibrium of the model assuming bail-ins do not exist and I compare the equilibrium outcome in this *pre-bail-in* world with the one emerging once bail-ins are introduced.

Absent bail-in, the only choice for the government when facing banks in distress is between bail-out and liquidation. In this case, as long as $\lambda \leq \overline{NPV} - L$, the government will strictly prefer to bail out the bank in case of failure of the first investment. Investors, anticipating this, require a repayment $R_1 = 1$ in the first investment stage, given the implicit guarantee of bailout provided by the government. The manager also anticipates that the government will bail out the bank if the project fails and, in this case, he will get all the profits coming from the second investment stage. Therefore, his incentive constraint is:

$$p_H(x-1) + (1-p_H)\,\overline{NPV} \geqslant p_L(x-1) + (1-p_L)\,\overline{NPV} + B.$$

that can be written as:

$$\frac{B}{\Delta p} \leqslant x - 1 - \overline{NPV} = x(1 - p_H) \equiv \Psi_{BO}. \tag{1.13}$$

However, the market is not able, per se, to discipline the manager. Indeed, investors lend to the bank regardless of banker's behavior since they anticipate that the government will pay them back in case of failure of the project. It follows that in the *pre-bail-in* Subgame Perfect Equilibrium:

- investors always lend to the manager of the bank;
- the government always saves the bank through a bailout in case of failure of the first investment;
- the manager of the bank monitors only when moral hazard is low enough, that is, when $\frac{B}{\Delta p} \leqslant \Psi_{BO}$ (where Ψ_{BO} could be higher or lower than Ψ_{BI} as developed later).

Hence, this equilibrium can be efficient or inefficient depending on the degree of moral hazard and on the model parameters. When moral hazard is low enough and the project is highly profitable - since x is large - a bailout is the first-best policy for the government. Vice versa, when moral hazard is severe and the return from the project in case of success is low, anticipating a bailout leads to an equilibrium in which the bank is able to raise funds to finance its investment but has no incentives to monitor the first project. In this case, bailouts generate a welfare loss since a negative NPV project is financed in the first investment period and only liquidation would be efficient.

Therefore, whilst bail-ins may lead to the freezing of the credit market, bailouts can lead to a welfare loss due to the lack of incentives coming from the implicit guarantee of public intervention. So, in order to compare these two resolution mechanisms, one should compare the threshold levels for $\frac{B}{\Delta p}$ in the equilibrium with bail-in and in the one *pre-bail-in*.

By comparing Ψ_{BI} and and Ψ_{BO} one can easily see that none of these thresholds is always larger or smaller than the other. Therefore there are cases in which the introduction of bail-ins generate a welfare improvement, basically when $\Psi_{BO} \leq \Psi_{BI}$, and cases in which the opposite happens since $\Psi_{BI} \leq \Psi_{BO}$.

In such circumstances, the introduction of bail-ins can generate a welfare loss that would not have occurred with bailouts. Indeed, if $\frac{B}{\Delta p}$ is included in the interval $[\Psi_{BI}, \Psi_{BO}]$ bail-ins lead to a credit market freeze because of moral hazard whilst bailouts would have provided the right incentives to monitor to the manager and allowed him to finance the investment. The interval $[\Psi_{BI}, \Psi_{BO}]$ is not empty when

$$\underbrace{p_H x - 1}_{\overline{NPV}} \leqslant 2\left(\frac{1-p_H}{p_H}\right). \tag{1.14}$$

Intuitively, when the probability of success of the project and its net present value conditional on monitoring are relatively low, bailouts can be more efficient than bail-ins.

1.3.4. The pure-strategy equilibrium with pre-commitment

In Section 1.3.2, I show that, in a subgame perfect equilibrium, the government always opts for a bail-in when dealing with a failing bank, provided this does not violate the manager's incentives to monitor in the second investment stage. However, anticipating that the government always prefers bail-in to both bailout and liquidation can generate an adverse reaction in the credit market, thus leading to a credit market freeze. When this is the case, the government can not do anything to increase social welfare but credibly pre-commit to an alternative resolution strategy at the beginning of the game.

So I consider the case in which (1.12) does not hold - that is, the credit market freezes at the beginning of the game - and I assume that the government can credibly pre-commit to an alternative resolution mechanism in t_0. As already mentioned, the choice between bailout and liquidation depends on the liquidation value of the bank and on the cost of transferring money from the public to the private sector. Indeed bailout dominates liquidation when $\lambda R_1^{BO} < \overline{NPV} - L$, and vice versa.

Of course, when the government pre-commits to bail out the bank in case of failure, competitive investors always lend to the bank at a gross return R_1^{BO} equal to 1. It follows that the second best option available to the government will be:

- Liquidation, if $\lambda > \overline{NPV} - L$.
- Bailout, if $\lambda \leqslant \overline{NPV} - L$.

These two cases are separately analyzed in the following sub-sections.

Liquidation preferred to bailout

Liquidating the bank is socially preferred to bailing it out when $\lambda > \overline{NPV} - L$. Such a situation might emerge, for example, in weak economies in which bailouts are relatively costly and large financial institutions are too-big-to-save. If so, the government should optimally pre-commit to liquidation in order to avoid the freezing of the credit market, thus allowing the bank to operate in the first investment period. However, this strategy would be optimal only if the manager is expected to monitor the first project, that is, when the competitive gross return required by investors expecting a liquidation satisfies the incentive constraint of the manager.

Hence, the participation constraint of outside investors in t_0 is

$$p_H \min\{R_1, x\} + (1 - p_H)L \geqslant 1$$

and competition among investors implies

$$R_1^L = \frac{1}{p_H} - \frac{(1 - p_H)\,L}{p_H}.$$

The incentive constraint of the manager, given that the bank is not going to be saved by the government is

$$R_1^L \leqslant x - \frac{B}{\Delta p} \equiv \hat{R}_1^L$$

and, replacing R_1^L, I find that pre-committing to liquidation is incentive compatible when

$$\frac{B}{\Delta p} \leqslant x - \frac{1}{p_H} + \frac{1 - p_H}{p_H}L. \tag{1.15}$$

Assumption 2 implies that condition (1.15) is always satisfied. Therefore, when bail-ins are not feasible because of moral hazard and the social cost of bailouts is too high - because $\lambda > \overline{NPV} - L$ - the government optimally pre-commits to liquidation in the pure-strategy subgame perfect equilibrium with pre-commitment.

Proposition 2 *When moral hazard is so severe that bail-ins lead to the collapse of the credit market and the cost of bailouts exceeds the benefits coming from rescuing the failing bank, it is optimal for the government to pre-commit to liquidate the bank in case of failure of the first project, thus providing the manager with enough incentives to monitor and allowing the bank to get financing in the first investment stage.*

Bailout preferred to liquidation

In the previous sub-section I considered the case in which liquidation is socially preferred to bailout. Now, I analyze the opposite scenario, that is, when the benefit from rescuing the bank is larger than the cost of the bailout. This is the case when $\lambda \leqslant \overline{NPV} - L$.

As shown in Section 1.3.3, bailouts are efficient if

$$\frac{B}{\Delta p} \leqslant x(1 - p_H) \equiv \Psi_{BO}.$$

Hence, as long as $\frac{B}{\Delta p}$ is low enough, bailouts can be part of the equilibrium with pre-commitment. When instead the above condition does not hold, the government has to pre-commit to liquidation since it is the only resolution mechanism that allows the bank to get financing in t_0.

Of course, since the government pre-commits to alternative resolution mechanisms only if bail-ins lead to the freezing of the credit market, pre-committing to bailout can be an equilibrium strategy only if the threshold below which bailouts are feasible, Ψ_{BO} is higher than the one below which bail-ins are feasible, that is,

Ψ_{BI}. As already shown, this is the case when

$$\underbrace{p_H x - 1}_{\overline{NPV}} \leqslant 2\left(\frac{1-p_H}{p_H}\right).$$

Therefore, in the cases in which bailouts are more efficient than bail-ins, they can be part of an equilibrium with pre-commitment if moral hazard is so severe that it prevents the government from adopting bail-in as the unique resolution mechanism when dealing with failing banks.

Proposition 3 *When bail-ins cannot be part of the SPNE of the game because of moral hazard and the cost of bailouts is low enough, in the Subgame Perfect Nash Equilibrium of the game it is be optimal for the government to pre-commit to bail out the bank in case of failure of the first project, as long as*

$$\frac{B}{\Delta p} \leqslant x(1-p_H) \equiv \Psi_{BO}. \tag{1.16}$$

If this condition is violated, pre-committing to liquidation is the only pure strategy the government can adopt in order to allow the bank to get financing in the first investment stage, even though, ex-post, it provides the lowest outcome in terms of social welfare compared to the alternative resolution mechanisms.

This is one of the key results of the model. Indeed, it proves that bailouts can be preferred to bail-ins when moral hazard is severe. The intuitive explanation for this result is the following: when investors expect a bail-in, they require a higher return on their debt and, if this return is too high, the manager has no incentives to monitor the investment of the bank. When this happens, pre-committing to bailout can mitigate moral hazard simply because the implicit guarantee of a bailout provided by the government reduces the cost of debt for the bank so much that the manager has no incentives to misbehave. In other words, by reducing the cost of debt, bailouts mitigate moral hazard thus allowing the bank to get financing in situations in which bail-ins would freeze the credit market.

Figure 1.3 provides a graphical representation, in the space $[p_H, B]$, of the equilibrium strategies of the government in case $\overline{NPV} < 2\left(\frac{1-p_H}{p_H}\right)$ and $\lambda \leqslant$

$\overline{NPV} - L$. As one can see from the figure, in which the lower and the upper bound for p_H, namely $\underline{p_H}$ and $\overline{p_H}$, come from (1.1) and (1.3), three different regions can be identified depending on the severity of moral hazard and on the probability of success of the project. When B is relatively low - and moral hazard is not very severe - the government can optimally bail in the insolvent bank. When moral hazard is high, instead, it has to pre-commit to liquidation. Finally, when moral hazard is too severe to allow bail-ins but no so severe to require pre-commitment to liquidation, the government can optimally pre-commit to bailout insolvent banks. Interestingly, the region in which the government optimally pre-commits to bailout becomes larger for higher values of p_H, that is, when the project financed by banks become safer. It follows that, according to the model, bailouts become more efficient as the riskiness of bank's portfolio decreases.

1.3.5. The equilibrium with pre-commitment to a mixed strategy

When bail-ins are not feasible because of moral hazard the government can improve welfare by pre-committing to bail out or to liquidate the insolvent bank. The choice between the two depends on the magnitude of the cost of transferring money from the public to the private sector.

In this subsection, I enrich the class of strategies and characterize the equilibrium of the game under the assumption that, when bail-ins are not feasible because $\frac{B}{\Delta p} > \Psi_{BI}$, the government can credibly pre-commit to a mixed strategy that randomizes over different resolution mechanisms. Although this mixed strategy equilibrium dominates the equilibrium with pre-commitment to a pure strategy, this is presented after the latter since it is relatively less relevant from a policy perspective. Indeed, mixed strategies in the hands of the regulator are not that credible. However, it is still worth to describe such an equilibrium, and one can interpret the probabilities characterizing it as the optimal frequency with which the regulator should adopt each of the available resolution mechanisms when the game is repeated over time with a sufficiently large number of banks.

So, in this case, I assume that the government can credibly announce and pre-commit to the following mixed-strategy when dealing with an insolvent bank:

- bail-in with probability z;
- bailout with probability y;
- liquidation with probability $(1-z-y)$.

Given the strategy announced by the government, the participation constraint of outside investors in t_0 is:

$$p_H R_1 + (1-p_H)\left[z(1-\alpha)\overline{NPV} + yR_1 + (1-y-z)L\right] \geqslant 1$$

and the competitive interest rate is:

$$R_1^{MS} = \frac{1-(1-p_H)\left[z(1-\alpha)\overline{NPV} + (1-z-y)L\right]}{p_H + (1-p_H)y}.$$

Then the incentive constraint of the manager, given the strategy announced by the government, is:

$$R_1 \leqslant x - (\alpha z + y)\overline{NPV} - \frac{B}{\Delta p} \equiv \hat{R}_1^{MS}$$

Using the competitive interest rate in the incentive constraint of the manager, the condition ensuring that the manager is able to get financing in t_0 is:

$$R_1^{MS} = \frac{1-(1-p_H)\left[z(1-\alpha)\overline{NPV} + (1-z-y)L\right]}{p_H + (1-p_H)y} \leq$$
$$x - (\alpha z + y)\overline{NPV} - \frac{B}{\Delta p} \equiv \hat{R}_1^{MS}$$

and the government faces the following maximization problem:

$$\max_{z,y}\,(z+y)\left(\overline{NPV} - L\right) - y\lambda R_1^{MS} + L$$

$$\text{subject to} \quad : \quad \begin{cases} R_1^{MS}(\alpha, z, y) \leqslant \hat{R}_1^{MS}(\alpha, z, y) \\ z + y \leqslant 1 \\ z, y \in [0,1] \end{cases}$$

Since the competitive interest rate increases in α whilst $\hat{R}_1^{MS}$ is decreasing in

α, the government can optimally set $\alpha = \underline{\alpha}$ in order to relax the incentive compatibility constraint and the problem becomes:

$$\max_{z,y} (z+y)\left(\overline{NPV}-L\right) - y\lambda R_1 + L$$

$$\text{s. to} \quad : \quad \begin{cases} R_1^{MS}(\underline{\alpha}, z, y) \leqslant \hat{R}_1^{MS}(\underline{\alpha}, z, y) \\ z + y \leqslant 1 \\ z, y \in [0,1] \end{cases}$$

Therefore, the optimal strategy adopted by the government consists in the pair (z, y) that maximizes welfare without violating the incentive compatibility constraint.

Proposition 4 *In the SPNE with pre-commitment to a mixed strategy, the optimal strategy of the government depends on the deadweight cost of tax revenue, λ:*

- *when λ is relatively high, the government randomizes over bail-in and liquidation, and it never bails out the bank;*
- *when λ is relatively low, the government randomizes over bail-in and bailout, and it never liquidates the bank;*
- *for intermediate values of λ, the government can optimally announce a mixed strategy involving bail-ins, bailouts and liquidation.*

(See Proof 2 in the Appendix 1.A)

1.3.6. The effect of competition and banks' equity issues

One of the main results from the model is that bail-in policies can lead to a credit market freeze. In this subsection, I introduce competition among banks and the possibility for banks to issue equity and I show that this result is not affected by the degree of competition in the banking sector and it holds regardless of the capital structure of the bank.

The equilibrium with bank competition

In this first extension of the model I consider an economy populated by a number of banks competing for credit and I show that Proposition 1 holds also when considering perfect competition among banks.

If banks compete for funds, so that investors appropriate all the expected surplus of the project, the equilibrium gross returns on debt are not those that satisfy investors' participation constraint as an equality but those that satisfy the manager's incentive constraint as an equality. Therefore, in the second investment stage, if the bank was saved through a bail-in, the equilibrium return is

$$R_2^C = x - \frac{B}{\alpha \Delta p}. \tag{1.17}$$

This return is compatible with outside investors' participation constraint, namely

$$p_H \min\{x, R_2^C\} \geqslant 1,$$

only if the manager is entitled to a fraction of bank shares no lower than

$$\underline{\alpha} = \frac{B p_H}{\Delta p \overline{NPV}},$$

exactly as in the baseline model.

So, also in this case, a bail-in with any $\alpha \in [\underline{\alpha}, 1]$ is the social maximizing option available to the government in case of bank failure after the first investment stage.

Anticipating this, manager's incentive constraint in the first investment stage - since $\alpha = E[\alpha]$, on the equilibrium path - is:

$$p_H(x - R_1^C) + \alpha\,(1 - p_H)\,p_H(x - R_2^C) \geqslant p_L(x - R_1^C) + \alpha\,(1 - p_L)\,p_H(x - R_2^C) + B.$$

Using the equilibrium R_2^C from equation (1.17) in this constraint, and solving it as equality yields the equilibrium gross return in the first investment stage, that is:

$$R_1^C = x - \frac{B}{\Delta p}(1 + p_H). \tag{1.18}$$

Of course, this return also satisfies the participation constraint of outside investors, that is:

$$p_H R_1^C + (1 - p_H)(1 - \alpha)(x - R_2^C) \geqslant 1.$$

Replacing R_1^C and R_2^C with their equilibrium values, this condition can be written as a condition on α, which is:

$$\alpha \leqslant \frac{(1 - p_H) p_H B}{2 p_H B - \overline{NPV} \Delta p} \equiv \bar{\alpha}^C. \tag{1.19}$$

Hence, exactly as in the baseline model, there are two bounds on α, the fraction of shares that is left to the manager in case of a bail-in. Therefore, a Subgame Perfect Nash equilibrium in which the bank gets financing in both the investment stages and the government opts for a bail-in in case of failure of the first project, requires the set $[\underline{\alpha}, \bar{\alpha}^C]$ to be non-empty, that is $\underline{\alpha}$ has to be lower than $\bar{\alpha}^C$.

As in the baseline model, $\underline{\alpha} \leqslant \bar{\alpha}^C$ can be written as a condition on the degree of moral hazard:

$$\frac{B}{\Delta p} \leqslant \left(x - \frac{1}{p_H}\right)\left(1 - \frac{p_H}{2}\right),$$

which is exactly the same of Proposition 1. The latter therefore holds even in presence of perfect competition among banks.

Intuitively, the degree of competition among banks changes the equilibrium gross returns that have to be promised to outside investors in both the investment stages, but it does not affect the threshold value for $B/\Delta p$ above which bail-in policies lead to the freezing of the credit market.

The equilibrium with equity issuance

Another assumption in the baseline model is that the bank can finance the project only through standard debt contracts and do not issue equity. In this subsection, I remove this assumption, allowing the bank to issue both equity and debt at the beginning of the game in order to finance its investment.

In particular, I assume that, at time 0, the manager of the bank can sell a fraction ϕ of bank shares in the market, in exchange for an amount of money equal to γ, that is used to finance the project in the first investment stage, together with $1-\gamma$ debt. I also assume the bank cannot issue equity in the second investment stage, if the bank was saved through a bail-in after the failure of the first project.[12] Finally, I consider again the case of competitive investors, for simplicity. Starting from these assumptions, I solve again the model through backward induction.

In the second investment stage, on the equilibrium path (that is, after a bail-in occurred in t_1), the manager is able to get financing if he promises a gross repayment to debtholders that satisfies their participation constraint, namely:

$$p_H \min\{x, R_2\} \geq 1,$$

and therefore, in equilibrium

$$R_2 = \frac{1}{p_H}.$$

Although equity issuance does not change the equilibrium return in the second investment change, it does affect manager's incentive constraint after a bail-in. Indeed, in a bail-in, equityholders are entitled to a fraction α of bank shares, whilst the remaining fraction, $1-\alpha$, goes to bailed-in debtholders. Given that the manager sold a fraction ϕ of bank shares at the beginning of the game, he is now entitled to a fraction $\alpha(1-\phi)$ of bank profits, whilst a fraction $\alpha\phi$ goes to investors that bought equity in the first investment stage.

Knowing this, the incentive constraint of the manager is:

$$\alpha(1-\phi)p_H(x-R_2) \geqslant \alpha(1-\phi)p_L(x-R_2) + B$$

that can be written as

$$R_2 \leqslant x - \frac{B}{\alpha(1-\phi)\Delta p} \equiv \hat{R}_2^E. \tag{1.20}$$

Hence, the manager is able to raise funds in the second investment stage only if $R_2 \leqslant \hat{R}_2^E$, that is when the competitive return on debt does not violate the manager's incentive constraint.

[12] Issuing equity after a bail-in is indeed likely to be extremely costly for the bank.

This is the case only when the fraction of bank shares left to the manager in the bail-in is large enough, that is when

$$\alpha \geqslant \frac{Bp_H}{\Delta p \overline{NPV}(1-\phi)} \equiv \underline{\alpha}^E. \tag{1.21}$$

The first thing to notice is that this threshold value for α is lower than 1 only if

$$\phi \leqslant 1 - \frac{Bp_H}{\Delta p \overline{NPV}} \equiv \bar{\phi}. \tag{1.22}$$

In other words, it is impossible to have an equilibrium with financing in the second investment stage if the amount of equity issued by the bank in the first investment period is too large. This happens because, in this case, the manager would be entitled to a very small fraction of bank profits after the bail-in, and would have no incentives to monitor the investment of the bank after the bank was saved.

Therefore, an equilibrium in the second investment stage in which the manager is able to get financing and to invest in the project requires that, in case of bail-in, the fraction of shares that remains to 'old' equityholders (that is, to the manager and to the investors that bought equity in t_0) has to be no-lower than $\underline{\alpha}^E$. And this is possible only when the fraction of shares sold by the manager to finance the first project is lower than $\bar{\phi}$.[13]

Comparing this threshold value for α with the one I defined in the baseline model, immediately gives that equity issuance in t_0 exacerbates moral hazard in the second investment stage, since it reduces the fraction of profits that goes to the manager and therefore his incentives to monitor the project. In particular, the larger is the amount of equity issued by the bank, the larger is the minimum α that has to be given to shareholders in order to make sure that the investment in t_2 has a positive net present value.

In t_1, as in the baseline version of the model, the social-maximizing choice available to the government in case of failure of the bank after the first period is to

[13] This is an interesting result on its own account, especially because it holds both for bail-in and for bailout: it shows that, when the government cannot pre-commit not to liquidate banks, ex-ante these have an incentive to remain undercapitalized, in the sense of not issuing too much outside equity.

bail in the bank, with any $\alpha \in \left[\underline{\alpha}^E, 1\right]$, as long as this set is non-empty, that is if $\phi \leqslant \bar{\phi}$. Interestingly, this threshold value for ϕ, above which the manager has no incentives to monitor in the second investment stage, is the same if we consider that a bail out occurred after the failure of the first project. Therefore, the manager has no incentives to sell more than $\bar{\phi}$ shares of the bank in t_0, given that, if he does so, the government will liquidate the bank for sure in case of failure of the first investment project. So, the manager always sells a fraction of bank shares ϕ lower or equal than $\bar{\phi}$.

Hence, in the first investment stage, the manager can finance the project issuing both debt and equity. In particular, the manager borrows $1-\gamma$ from outside investors and receives γ from investors who purchase equity, in exchange for a fraction ϕ of bank shares. In order to make sure the bank is able to raise funds, both the participation constraint for debtholders and equityholders have to be satisfied. The participation constraint of debtholders is

$$p_H R_1 + (1-p_H)(1-\alpha)\overline{NPV} \geqslant 1-\gamma, \tag{1.23}$$

and the one for equityholders is

$$p_H \phi(x-R_1) + (1-p_H)\phi\alpha\overline{NPV} \geqslant \gamma. \tag{1.24}$$

Finally banker's incentive constraint becomes:

$$\begin{aligned} p_H(1-\phi)(x-R_1) + (1-p_H)\,\alpha(1-\phi)\overline{NPV} \geqslant \\ p_L(1-\phi)(x-R_1) + (1-p_L)\,\alpha(1-\phi)\overline{NPV} + B. \end{aligned} \tag{1.25}$$

Competition among lenders implies that their participation constraint, in equilibrium, is satisfied as equality and therefore the equilibrium gross repayment on debt is

$$R_1 = \frac{1-\gamma}{p_H} - \frac{(1-p_H)(1-\alpha)\overline{NPV}}{p_H}.$$

Substituting this equilibrium return on debt into the participation constraint of equality holders yields

$$\gamma \leqslant (2 - p_H)\overline{NPV}\frac{\phi}{1-\phi}. \tag{1.26}$$

Assuming competition in the market for equity implies that also this constraint has to hold as equality, which yields the equilibrium value of γ, depending on the fraction of bank shares the manager sells.

Finally, replacing both R_1^E and γ into the banker's incentive constraint (equation 1.25), yields another condition on α, that is:

$$\alpha \leqslant \frac{2 - p_H}{1-\phi} - \frac{Bp_H}{\Delta p\overline{NPV}(1-\phi)} \equiv \bar{\alpha}^E. \tag{1.27}$$

Hence, as in the baseline version of the model, an equilibrium in which the manager is able to get financing in both investment stages and the government opts for a bail-in upon failure of the first project, requires the set $[\underline{\alpha}^E, \bar{\alpha}^E]$ to be non-empty. This is the case when $\underline{\alpha}^E \leqslant \bar{\alpha}^E$. Again, this condition can be rewritten as a condition on $\frac{B}{\Delta p}$, that is on the severity of moral hazard, which is:

$$\frac{B}{\Delta p} \leqslant \left(x - \frac{1}{p_H}\right)\left(1 - \frac{p_H}{2}\right).$$

Also in this case, Proposition 1 holds. Even though equity issuance change the equilibrium gross returns that have to be promised to outside investors in both the investment stages, it does not affect the threshold value for $B/\Delta p$ above which bail-in policies lead to the the credit market freeze and therefore it does not mitigate the problem associated to bail-in policies.

1.4. Conclusions

When a systemically important financial institution experiences a distress event, governments and central banks faces a complicated trade-off: on the one hand, a bailout can reduce the social cost implied by the failure of a large financial institution, thus averting the threat of fire sales and contagion; on the other hand, saving large banks is costly, both in terms of resources the government needs to transfer to the failing institution and in terms of moral hazard. A possible solution to this trade-off is offered by a statutory bail-in, a resolution mechanism that is becoming increasingly popular. Indeed, an automatic debt-equity swap imposed by the regulator would allow governments to rescue banks without using taxpayers' money and, according to most of the existing literature, mitigating the moral hazard problem implied by bailouts.

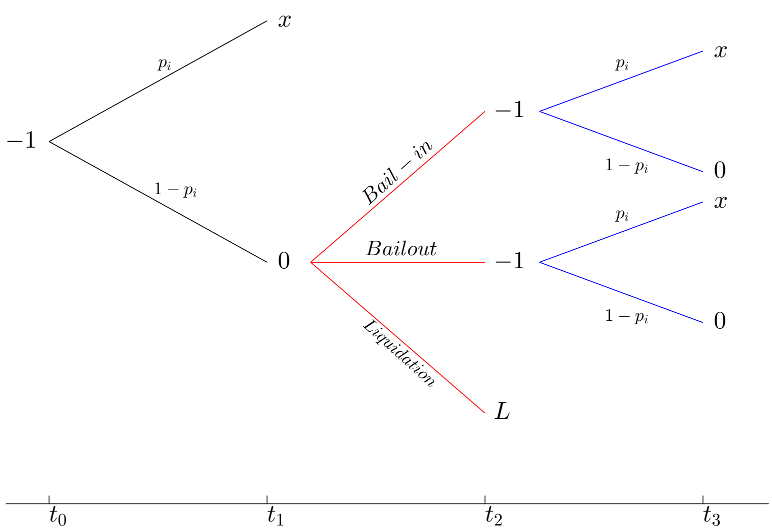
This paper analyzes the link between bail-in policies (and in particular *open bank* bail-ins), cost of debt and bank management's behavior and shows that bail-ins are not always the optimal solution to be adopted when dealing with distressed banks. In a model *à la* Holmstrom and Tirole (1997) with two investment stages, both characterized by moral hazard, bail-ins may distort banks' incentives to monitor on their loans. Indeed, by imposing losses also on debtholders, bail-ins increase the cost of capital, thus reducing banks' profits. This reduces bankers' incentives to monitor, and this in turn reduces investors' willingness to lend to the bank and - when moral hazard is particularly severe - leads to the breakdown of the credit market. Therefore, although they are the first best solution *ex-post*, bail-ins can have dramatic *ex-ante* effects on banks' financing capacity. This result holds regardless of the degree of competition in the banking sector and is not affected by the capital structure of the bank.

In some cases, the credit market freeze occurs in circumstances in which a bailout regime would have been efficient. In this sense, bail-ins are not necessarily superior to bailouts. Therefore, in order to avert the risk of a credit market freeze, governments have to credibly pre-commit to alternative resolution mechanisms for failing banks, that is either to bail out or to liquidate the troubled institution. Both alternative resolution mechanisms can mitigate the severity of moral hazard, through different channels. Intuitively, pre-committing to liquidation has the desirable effect of disciplining the manager of the bank, thus providing the right incentives to monitor the investment, whilst the implicit guarantee on bank debt provided by bailouts can reduce the cost of debt for banks so much that the manager has no incentives to misbehave. If possible, it is optimal for the government to announce a mixed-strategy that depends on the deadweight cost of public funds. When this cost is high, the government optimally pre-commits to randomize over bail-ins and liquidations whilst, when this cost is relatively low, a randomization over bail-ins and bailouts is preferred. Finally, for some parameter constellations of the model, a mixed strategy involving all the three resolution mechanisms is optimal.

To conclude, a bail-in is an appealing mechanism available to central banks and policy makers that should be handled with care. When announcing policies based on mandatory bail-in to be implemented in case of bank failure, governments should not ignore the consequences these can have on banks' behavior and in the credit market. Hence, bail-ins should not be considered as a *panacea* for the too-big-to-fail mechanism and should be used together with alternative resolution mechanisms, including bailouts, rather than replacing them.

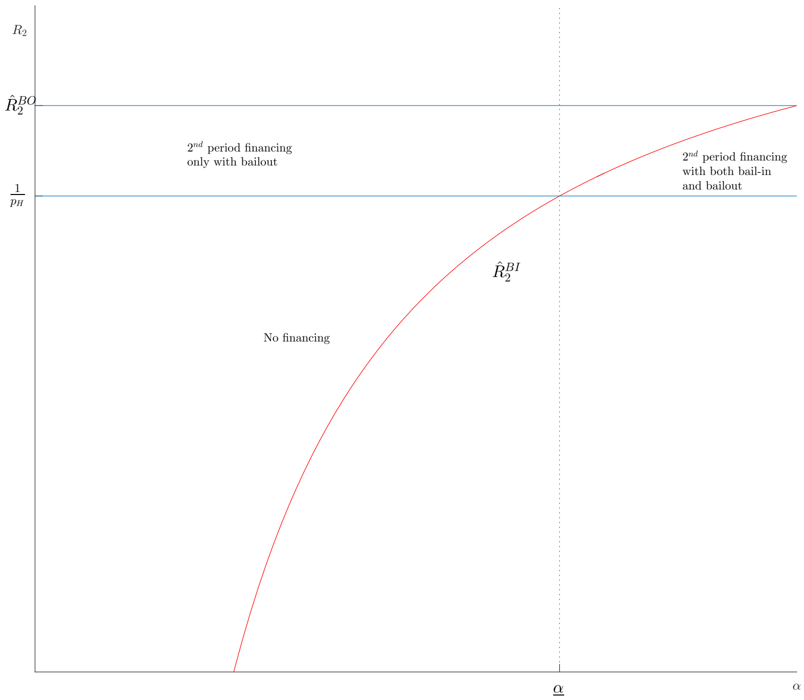
Starting from this conclusion, much research remains to be done to deepen the understanding of the effects of bail-in policies on the banking system. The effects bail-ins can have in presence of bank-runs, as well as their interactions with the risk of contagion among banks, for instance, are two of the most relevant issues to be addressed in future research.

Figure 1.1: Timeline of the model



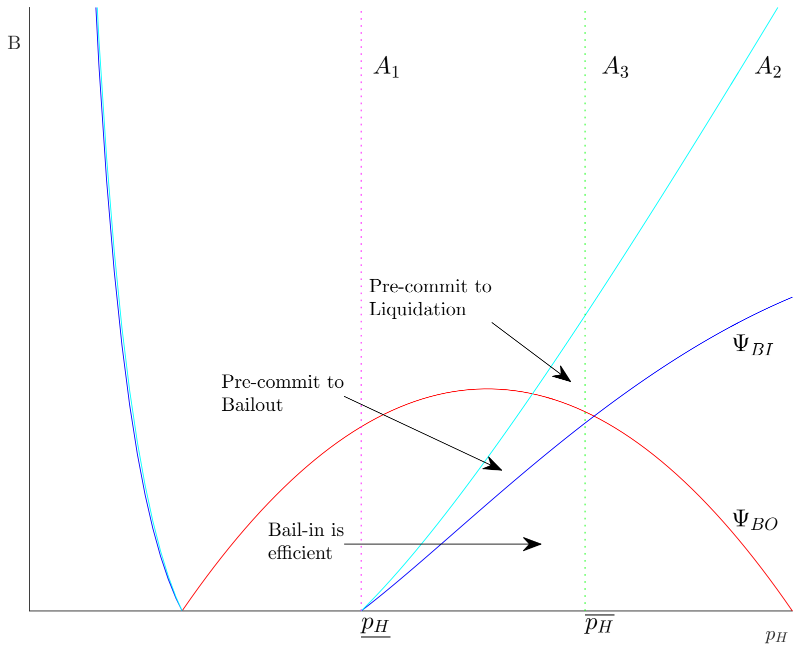
Note: This figure plots the timeline of the game. In t_0 the banker invests in the first project, if he is able to raise funds. In t_1 the outcome is observed and, if it fails, the government chooses whether to save the bank or not. In t_2 a second investment stage occurs, whose outcome is observed in t_4.

Figure 1.2: The equilibrium in the second investment stagel



Note: This figure represents the equilibrium in the second investment stage, in the space $[\alpha, R_2]$. $\hat{R}_2^{BO}$ is the maximum repayment that can be promised to debtholders without violating the incentive constraint of the manager after a bailout. $\hat{R}_2^{BI}$ is instead the maximum incentive-compatible return that can be promised after a bail-in. While the former is independent of the α, the latter is an increasing and concave function of the amount of shares left to the banker.

Figure 1.3: Timeline of the model



Note: This figure provides a graphical representation of the equilibrium strategies of the government when $\overline{NPV} < 2\left(\frac{1-p_H}{p_H}\right)$ and $\lambda \leqslant \overline{NPV} - L$.

1.A. Appendix

1.A.1. Proof 1

If investors expect the manager not to monitor, their participation constraint is

$$p_L \min\{x, R_1\} + (1 - p_L)\,(1 - \alpha)\,\overline{NPV} \geqslant 1.$$

The left-hand-side of the inequality is increasing in $\min\{x, R_1\}$ and decreasing in α, and so it is maximized when $\min\{x, R_1\} = x$ and $\alpha = \underline{\alpha}$, that is when the manager promises to give debtholders the entire profit coming from the initial investment in case of success and the government is expected to bail in the bank leaving to the manager the lowest possible fraction of shares satisfying incentive compatibility in t_2. In this case, the participation constraint reduces to

$$p_L x + (1 - p_L)\left(\overline{NPV} - \frac{Bp_H}{\Delta p}\right) \geqslant 1.$$

and, rearranging this expression, it can be written as:

$$\frac{B}{\Delta p} \leqslant x - \frac{1}{p_H} + \frac{\underline{NPV}}{p_H(1 - p_L)} \equiv \Psi_1.$$

Therefore, in order to have an equilibrium in which investors lend to the manager even when they expect him not to monitor in the first investment stage, the threshold Ψ_1 should be positive, that is

$$\begin{aligned}
x - \frac{1}{p_H} + \frac{\underline{NPV}}{p_H(1 - p_L)} &\geqslant 0 \\
\frac{\overline{NPV}}{p_H} + \frac{\underline{NPV}}{p_H(1 - p_L)} &\geqslant 0 \\
\overline{NPV} + \frac{\underline{NPV}}{1 - p_L} &\geqslant 0 \\
\overline{NPV} &\geqslant -\frac{\underline{NPV}}{1 - p_L},
\end{aligned}$$

which clearly violates 3. Hence, investors never lend to the bank unless in t_0 when the manager is expected to misbehave.

1.A.2. Proof 2

• When $\lambda \to \infty$, the welfare function of the government tends to $-\infty$ for any value of y different from 0. Therefore, the regulator optimally chooses a probability of default $y = 0$. When this is the case the IC for the manager can be written as

$$1 - (1 - p_H)\left[z\left(\overline{NPV} - \frac{p_H B}{\Delta p} - L\right) + L\right] - \left[p_H x - p_H^2 \frac{B}{\Delta p} z - \frac{p_H B}{\Delta p}\right] \leqslant 0.$$

The incentive constraint, evaluated in $y = 0$, does not hold for $z = 1$, since $\frac{B}{\Delta p} > x - \frac{1}{p_H} - \frac{\overline{NPV}}{2}$ while it holds for $z = 0$, given (2). Moreover, the left-hand-side of the inequality is increasing in z, being

$$\begin{aligned} \left.\frac{\partial IC}{\partial z}\right|_{y=0} &= -(1 - p_H)\left(\overline{NPV} - L\right) + \frac{p_H B}{\Delta p} \geqslant 0 \\ &\Leftrightarrow \frac{B}{\Delta p} \geqslant (1 - p_H)\left(x - \frac{1}{p_H} - \frac{L}{p_H}\right) \end{aligned}$$

where $\frac{B}{\Delta p} \geqslant (1 - p_H)\left(x - \frac{1}{p_H} - \frac{L}{p_H}\right)$ is implied by $\frac{B}{\Delta p} > x - \frac{1}{p_H} - \frac{\overline{NPV}}{2}$. Therefore, the maximum possible z that the government can announce without violating the incentive constraint of the manager is the one that solves the constraint as equality, that is:

$$z^* = \frac{\overline{NPV} + (1 - p_H)L - \frac{p_H B}{\Delta p}}{\frac{p_H B}{\Delta p} - (1 - p_H)(\overline{NPV} - L)}.$$

Since welfare is higher in case of bail-in than in case of liquidation, the government optimally announces $z = z^*$, that is the maximum possible z satisfying the IC evaluated in $y = 0$. Hence, when $\lambda \to \infty$, the government optimally chooses $y = 0$ and $z = z^*$ with $z^* \in (0, 1)$, thus randomizing only over liquidation and bail-in.

• When $\lambda \to 0$, the government is indifferent between bailing in or bailing out the failing bank and both the strategies are preferred to liquidation. Therefore, it optimally chooses a pair (z, y) such that $(z + y)$ is maximized. Since I assume

$$\frac{B}{\Delta p} \leqslant x - 1 - \overline{NPV},$$

the pair $(z, y) = (0, 1)$ satisfies the constraint. Then, also the pair $(z, y) = (\varepsilon, 1 - \varepsilon)$ with $\varepsilon \to 0$ is feasible. Therefore, when $\lambda \to 0$, the government optimally announces a mixed strategy involving only bail-ins and bailouts.

• Finally, to show that in some cases the government randomizes over the three resolution mechanisms, I consider the following parameter constellation, satisfying all the assumptions of the model:

x	p_H	p_L	B	L	λ
2.3	0.7	0.2	0.3	0.4	.085

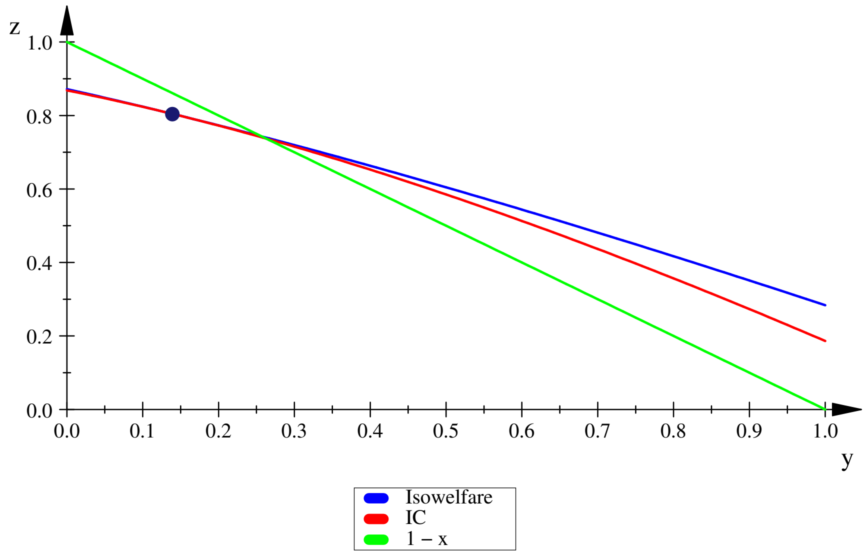
Then, solving the maximization problem of the government, the optimal mixed-strategy announced by the government is:

$$(z^*, y^*, 1 - z^* - y^*) = (0.804, 0.139, 0.057)$$

Therefore, at least for same parameters constellations and intermediate values of λ, the government optimally announces and pre-commits to a mixed strategy involving all the three possible resolution mechanisms. The intuition behind this result is that both liquidation and bail-out can reduce moral hazard: the former through an increase in the maximum interest rate that can be promised to outside investors and the second through a decrease in the competitive gross return required by investors. Therefore the government can optimally use both liquidation and bail-out to mitigate moral hazard and to maximize welfare.

Putting the probability of bail-in, z, on the vertical axis and the probability of bailout, y, on the horizontal axis, I provide a graphical representation of the maximization problem of the government in Figure 1.4. The locus of points that satisfy $R_1^{MS}(\underline{\alpha}, z, y) \leqslant \hat{R}_1^{MS}(\underline{\alpha}, z, y)$ as equality is a curve that delimits the feasible pairs (z, y) not violating the incentive compatibility constraint of the manager. This is the red line in the picture. In order to be feasible, a pair (z, y) has to lie below or at most on this curve. Moreover, it can not lie above the line $z = 1 - y$, the green one in the picture, so as not to violate the constraint $z + y \leqslant 1$. Finally I represent, in blue, the iso-welfare curve of the government that are the locus of points that give the same social payoff for different combinations of z and y. Therefore, the optimal pair (z^*, y^*) is the feasible pair that lies on the highest iso-welfare curve. For $\lambda = 0.085$ the optimal pair (z^*, y^*) corresponds to the tangency

Figure 1.4: The equilibrium in mixed strategies



point between the incentive constraint and the iso-welfare curve. Since this point does not lie on the green line, it is such that $z + y < 1$, so that the probability of liquidation is positive, as well as the probability of bailout. Therefore, in this case, the government optimally randomizes over the three resolution mechanism.

Chapter 2

CAPITAL FLOWS AND SOVEREIGN DEBT MARKETS: EVIDENCE FROM INDEX REBALANCINGS

2.1. Introduction

How do informationless international capital flows affect sovereign debt markets? Economic theory does not provide an unequivocal answer to this question. On the one hand, under the expectation hypothesis of the term structure of interest rates, changes in sovereign bond prices should only reflect changes in risk-free interest rates and expected default losses at the relevant maturities.[1] Thus, uninformative international capital flows should not affect sovereign debt prices. On the other hand, the preferred-habitat view of the term structure of interest rates

[1]Since we focus on emerging markets, we are adapting the notion of the expectation hypothesis of the term structure of interest rates to this type of countries. See for instance Broner et al. (2013).

predicts that changes in the demand for sovereign bonds may affect their prices.[2] Despite these stark theoretical predictions, there is little empirical evidence on the subject. In this paper we fill this gap by studying how international capital flows affect sovereign debt markets and to what extent these flows spill over to the exchange rate market.[3]

Understanding how capital flows affect sovereign debt markets is important for at least two reasons. First, sovereign debt markets are central to the macroeconomy of a country. Not only changes in the price and liquidity of sovereign debt securities affect the cost of financing for governments but they can also impact the extension of credit by financial institutions.[4] Second, international capital flows directed to sovereign debt markets have grown importantly in the last decade. Figure 2.1 depicts the cumulative gross inflows to emerging markets divided by the type of assets in both absolute and relative terms. Portfolio debt flows have overtaken portfolio equity flows in importance in the last decade, and their median growth rate has exceeded that of foreign direct investment inflows.[5]

In spite of its importance, the relationship between capital flows and sovereign debt markets has received little attention in empirical research so far. This can be attributed in large part to the difficulty of identifying a causal relationship from capital flows to sovereign debt returns and liquidity since these variables are all jointly determined. For instance, an improvement in the economic prospects of a country is likely to increase foreign demand for its government debt while reducing its probability of default. So it would trigger both capital inflows to the sovereign debt market and an increase in sovereign debt prices. However, the resulting correlation between capital flows and sovereign debt prices would not imply any causal relationship.

[2]See for example Vayanos and Vila (2009) and Greenwood and Vayanos (2010).

[3]Since this paper is concerned with sovereign debt markets, we use the term international capital flows to refer to net purchases of government debt securities by foreigners.

[4]See among others Adelino et al. (2017) for evidence on how changes in the cost of financing for governments affect economic activity. There is also a large literature on the relationship between sovereign debt and financial institutions. A theoretical contribution on this relationship is provided by Gennaioli et al. (2014). There are plenty of empirical studies on this topic such as Acharya et al. (2014), Becker and Ivashina (2014), Altavilla et al. (2017), and Williams (2017).

[5]Portfolio debt inflows include capital flows going to both government and private debt. However, in emerging markets government debt is a much more important and liquid market than that for private debt securities. See for instance Avdjiev et al. (2017).

This paper overcomes this endongeneity problem via a novel identification strategy, based on monthly index rebalancings in a major local currency sovereign debt market index constructed by J.P. Morgan for emerging markets. This index has a noticeable feature that is crucial for our identification strategy: the relative importance - *i.e.*, the *benchmark weight* - of any single country cannot exceed 10% of the index at the beginning of each month. This induces substantial monthly rebalancings for a purely mechanical reason. For instance, if a country that at the beginning of a month is at the 10% cap overperforms the other countries in the index, its benchmark weight at the end of the month will exceed 10%. As the rule establishes that no country can go above the aforementioned threshold, at the beginning of the subsequent month its weight in the index will be brought back to 10%. Moreover, as weights have to sum to 100%, the weights of the other countries in the index will also be adjusted. This index is also the most widely used benchmark by mutual funds that invest in sovereign debt in emerging markets. These funds tend not to deviate too much from the composition of their benchmark index in order to have a low tracking error.[6] Therefore, any rebalancing of the index is closely matched by a rebalancing in the portfolio of these funds. This feature, along with the mechanical rebalancings due to the 10% cap rule, potentially trigger informationless capital flows across countries at the end of each month.

To construct a measure of these informationless flows, we multiply the mechanical changes in benchmark weights by amount of assets under management benchmarked against this index, normalized by the size of the market of each country. We call this measure "Flows Implied by the Rebalancings" (FIR). We use FIR to estimate the impact of informationless capital flows on sovereign debt markets - using bond level data on prices and bid-ask spread - and exchange rates.

We show that FIR is positively associated with both cumulative returns and changes in the liquidity of sovereign debt securities around the rebalancing dates. Moreover, these flows spill over to the exchange rate market. Figure 2.2 illustrates our main results. Around the day of the rebalancing there is a clear divergence in the cumulative returns of sovereign debt prices for the most positive and negative

[6] Raddatz et al. (2017) document this fact at the international level for both equity and bond funds.

FIRs. While more short-lived, something similar happens for the cumulative percentage change in the bid-ask spreads of sovereign bonds. This divergence is also present for the exchange rate. In our main analysis we show systematically these effects, and we show that they are not only statistically significant but also quantitatively important, and consistent with episodes of large capital flows into the sovereign debt market. Importantly, we show that in the days prior to the rebalancing, the relationship between FIR and prices, liquidity and the exchange rate is very close to zero, and only becomes statistically significant after the rebalancing dates. This lends important support to our identification strategy.

We contribute to several different strands of literature. First, we contribute to a large literature on how demand shocks affect financial markets. This literature has mostly focused on equity markets at both the domestic or international level.[7] To our knowledge this is the first effort to understand the systematic effect of demand shocks on sovereign debt markets in a large cross-section of countries during several years. More broadly, we contribute to a large literature on the aggregate effects of institutional investors.[8] We effectively provide evidence that institutional investors in sovereign debt markets affect assets prices through their rebalancings.

Moreover, this paper is broadly related to the empirical literature studying the determinants of government bond yields. Several articles analyze which (global and local) factors affect government bond yields, focusing on both emerging and advanced economies.[9] More closely related to ours, some studies focuse on how changes in the foreign investor base of government debt affect government bond yields.[10] For emerging economies, there are a number of articles with evidence

[7]There is a long standing literature on how index redefinitions affect stock returns, pricing, and liquidity. See among others Harris and Gurel (1986), Shleifer (1986), Chen et al. (2004), Barberis et al. (2005), Greenwood (2005), Hau et al. (2010), Hau (2011), Claessens and Yafeh (2013), Vayanos and Woolley (2013), Chang et al. (2014), Raddatz et al. (2017).

[8]See among others Broner et al. (2006), Jotikasthira et al. (2012), Levy-Yeyati and Williams (2012) and Raddatz and Schmukler (2012).

[9]See for example Gonzalez-Rozada and Yeyati (2008) for evidence on emerging markets. For advanced economies, the European Sovereign Debt Crisis started a number of papers in this topic. See for example Afonso et al. (2015) and the references therein.

[10]For instance, Arslanalp and Poghosyan (2016) show that positive (negative) changes in the foreign investor base decrease (increase) government bond yields for advanced economies. See Warnock and Warnock (2009) for similar evidence on the United States.

in the same direction, with a somewhat stronger effect.[11] Our contribution to this literature is to provide plausible causal evidence that capital inflows (outflows) increase (decrease) sovereign debt prices, with a novel identification strategy.

Our evidence also bears on the effects of capital flows on market liquidity. Economic theory offers very different predictions: on the one hand, foreign investors may deepen the market by increasing the probability for market makers and local investors of executing their orders; on the other hand, they might withdraw liquidity if their presence increases the volatility of the market and generates order imbalances. Also the empirical evidence regarding this topic is mixed.[12] We present evidence that capital inflows improve liquidity in sovereign debt markets, at least temporarily, and capital outflows reduce it. Additionally, we contribute to the literature studying how flows from other asset markets affect the exchange rate market. Our evidence shows sovereign debt investment flows are transmitted to the exchange rate market, in line with previous findings for equity market flows.[13]

More broadly, this paper contributes to the literature studying whether capital flows are expansionary or contractionary. Several studies analyze whether capital inflows lead to higher credit growth and an increase in economic activity.[14] Most of these studies have problems addressing endogeneity issues, since capital flows are almost always related to local economic prospects. We avoid this pitfall, as we focus on capital flows triggered by near-mechanical rebalancings. Our evidence that even such capital flows increase bond prices and liquidity supports the idea that capital flows are expansionary, *per se*, at least in emerging countries.

The rest of the paper is structured as follows. Section 2.2 presents our empirical strategy based on index rebalancings. Section 2.3 details the data, results and robustness tests. Section 2.4 discusses the potential implication of our results. Section 2.5 concludes.

[11] See among others Peiris (2013) and Dell'Erba et al. (2013).

[12] See Vagias and Van Dijk (2011) for a detailed literature review on theory and evidence on this topic.

[13] See Hau et al. (2010) and references therein.

[14] For instance, Mendoza and Terrones (2012) find that credit booms are positively correlated with net capital inflows. Calderon and Kubota (2012) suggest that private capital inflows are good predictors of credit booms. In a more granular approach, Lane and McQuade (2014) argue that only net debt inflows generate domestic credit growth in European countries. In a related theoretical and empirical work, Blanchard et al. (2015) find that only equity inflows are correlated to credit expansions.

2.2. Index Rebalancings and Empirical Strategy

2.2.1. J.P. Morgan Government Bond Index EM Global Diversified

Our empirical strategy relies on the use of the most important local currency government debt index in emerging markets.[15] This index is constructed by J.P. Morgan and is named Government Bond Index EM Global Diversified (from here onward GBI-EM Global Diversified). The GBI-EM Global Diversified is part of the GBI-EM family of indexes. These indexes are constructed using a bottom-up approach and consist of local currency government debt securities in emerging markets. J.P. Morgan decides which countries are included in each of the indexes of the family, and then decides which securities of each country are part of each index. After this, they construct the *benchmark weight* (w_{ct}^B). This measures the relative importance of each country in an index. In most of the indexes of the GBI-EM family, this is simply the total market capitalization of securities from country c at time t - all of these indexes being rebalanced on a monthly frequency - included in benchmark B, divided by the total market capitalization of all securities included in benchmark B.[16]

In this paper, we use the rebalancings of the GBI-EM Global Diversified to identify informationless flows to sovereign debt markets. We focus on this index for two different reasons. First, this is the most important index for emerging markets sovereign debt in local currency. The assets under management benchmarked against this index as of the end of 2016 were 186 billions dollars, compared to only 20 billions dollars for the rest of the indexes in the GBI-EM family of indexes.[17] Second, the GBI-EM Global Diversified limits the benchmark weights so as to preserve the diversification of the index: countries in this index cannot have a benchmark weight higher than 10%. This generates substantial periodic rebalancings at the monthly frequency that are in principle uninformative and unrelated to

[15] In this paper we use the terms index and benchmark interchangeably.

[16] Before October 2013, the rebalancing took part the first weekday of each month. After this date, it takes place on the last weekday of each month.

[17] The assets benchmarked to the Barclays Emerging Markets Local Currency Government Index and the Citi Emerging Markets Government Debt Index are estimated to be much smaller than the ones benchmarked against the J.P. Morgan GBI-EM Global Diversified.

the economic prospects of a given country.[18]

We use such rebalancings alongside a documented feature of mutual funds largely documented by the finance literature: most international mutual funds track their performance against this type of benchmark indexes. A large portion of these funds have portfolios that closely resemble the composition of the benchmark index that they declare to follow.[19] Since these funds do not want to move away from their benchmark index, the monthly rebalancings potentially create capital flows across countries. Exploiting these features of the GBI-EM Global Diversified, we construct a measure to capture this notion of implied capital flows across countries.

2.2.2. Flows Implied by the Rebalancings (FIR)

To construct our measure we start from the following identity that captures the relation between benchmark weights and capital flows triggered by portfolio shifts of international mutual funds:

$$F_{ict} = w_{ict} F_{it} + \tilde{A}_{it} \left(w_{ict} - w_{ict}^{BH} \right), \tag{2.1}$$

where F_{ict} is the net investment flow (in dollars) from fund i into country c at time t. w_{ict} is the portfolio weight the fund decides to have in that country at time t, $\tilde{A}_{it} = R_{it} A_{it-1}$ is the value of the fund's assets at the beginning of time t, and w_{ict}^{BH} is the fund's buy-and-hold weight in that country resulting from movements in total and relative returns. F_{it} is the net inflow (in dollars) from investors to fund i at time t, also known as injections or redemptions.

We make three simplifying assumptions. First, we assume that $F_{it} = 0$ since we look at very short windows of time around each rebalancing in which net inflows of investors into these funds can be assumed to be negligible. Second, we assume that all international mutual funds act like passive funds and thus $w_{ict} = w_{ict}^{B}$ and $w_{ict}^{BH} = w_{ict}^{BH,B}$. While extreme, we base this assumption on the documented

[18]This is one of the reasons we do not focus on EMBI, which is the most important foreign currency government debt index for emerging markets. This index does not have any limit on benchmark weights, and the rebalancings for most of the countries are relatively small.

[19]See Cremers and Petajisto (2009) for evidence on the U.S. equity mutual fund industry. Cremers et al. (2016) and Raddatz et al. (2017) document this pattern at the international level.

feature that a large portion of mutual funds act as passive funds. Third, we assume $\tilde{A_{it}} = A_{it}$ for simplicity since it is difficult to get aggregate data on $\tilde{A_{it}}$. We sum across funds and normalize by market size to get our measure of flows implied by the rebalancings (FIR), that is therefore given by the following equation:

$$FIR_{ct} = \frac{A_t \lambda_{ct}}{MV_{ct-1}}, \tag{2.2}$$

where $\lambda_{ct} = (w_{ict}^{B} - w_{ict}^{BH,B})$ is the reallocation implied by the rebalancings. A_t is the total amount of dollars that are benchmarked against the GBI-EM Global Diversified, and MV_{ct-1} is the previous period market value of government debt securities in local currency (i.e. the size of the market). Intuitively, our measure captures the implied dollars that should enter or leave a country, at the time of each rebalancing, as a percentage of market size.

Figure 2.3 shows the distribution of FIR across countries. Two things emerge from this picture. First, although most of the rebalancings are small in size, some of them are quite large, as many implied rebalancings are in absolute value between 2 and 6 percent of the market value of the sovereign debt of a given country (left panel). Furthermore, most countries have an average FIR centered around 0, implying that FIR is not persistently positive or negative within each country.[20]

2.2.3. Empirical Strategy

We exploit our FIR measure alongside with the fact that the rebalancings are effective at the end/beginning of each month, and we estimate the following specification:

$$\Delta y_{jct}^{z} = \theta_t + \beta FIR_{ct} + \phi X_{jct} + \varepsilon_{jct}, \tag{2.3}$$

where $\Delta y_{jct}^{z} = y_{jct,d+z} - y_{jct,d-5}$ is the change in the log of our dependent variable

[20] In our database we drop the months of big rebalancing events in the J.P. Morgan GBI-EM Index such as the upgrade of Colombia, Nigeria and Romania, and the downgrade of Nigeria. This rebalancings are usually announced in the middle of the month, and generate large prices effects around these announcements. An example of this is documented for Colombia in Williams (2017). Since our identification strategy relies on the fact that all the rebalancings are done at month end, we drop these episodes.

of interest for bond j, from country c, in month t. The cumulative log change is measured over an interval that goes from 5 days prior to the rebalancing date, d, to z days after it. In our main specifications, $z = [3, 5, 7]$, since we look at the cumulative log change of y, that is, either the price or the bid-ask spread of bonds, 3, 5 and 7 days after the rebalancing. θ_t are time fixed effects indicating the month of each rebalancing, FIR_{ct} is our measure of informationless capital flows, X_{jct} is a vector of controls at the bond-time level such as life to maturity, and ε_{jct} is the error term.[21] We also analyze whether these uninformative capital flows spill over to the exchange rate market. In that case we only have country level data, so that our specification becomes

$$\Delta y_{ct}^{z} = \theta_t + \beta FIR_{ct} + \varepsilon_{ct} \tag{2.4}$$

where y_{ct} is the log of the exchange rate measured as dollars per local currency, and thus an upward (downward) movement signals a depreciation (appreciation). In both specifications, β captures how the flows implied by the rebalancings affect the cross section of returns in the sovereign debt market and in the exchange rate one. Additionally, we look at how it affects changes in bid-ask spread for government bonds, to test whether capital flows affect liquidity in sovereign debt markets.

The time dimension is a key part of our identification. If the flows implied by the rebalancings do not correlate with some country-specific unobservables that also affect prices, liquidity and exchange rates - thus being purely informationless and not driven by the macroeconomic conditions of a country - then FIR should not be associated to changes in the three variables of interest in the days immediately prior to the rebalancing. So, we perform a sort of placebo test alongside our main results and look at how our dependent variables correlate with FIR, in a day-by-day basis, before and after the rebalancing dates. Under our identification strategy we should observe that this relationship becomes significantly important

[21] We have only 16 countries in our sample and thus we cannot use clusters at the country level, which would be the ideal clustering for this specification. In the individual bond specification we cluster at the country-time to maturity level. Time to maturity is a dummy indicating whether a bond is maturing in 1 to 3, 3 to 5, 5 to 7, 7 to 10, or more than 10 years. In the exchange rate specification we use robust standard errors.

only on the rebalancing dates or immediately after. These tests not only confirm the goodness of our measure as a measure of rebalancing-driven informationless flows, but also provide evidence of the aforementioned fact that international mutual funds do not want to deviate far away from the benchmark weights, thus rebalancing their portfolios contemporaneously to the rebalancings of the index.

2.3. Data and Results

2.3.1. Data

The dataset used in the empirical analysis is obtained combining information from multiple data sources. First, we draw monthly data on *benchmark weights* and rebalancing events from the "Index Composition and Statistics" reports published on the J.P. Morgan Markets' website, from which we also get the value of the assets benchmarked against the Government Bond Index EM Global Diversified. Second, the list of ISIN of sovereign debt bonds issued in any of the countries included in the Index comes from Bloomberg. Finally, static data on bonds, as well as daily data on both bonds and exchange rates relative to the countries in the sample are from Datastream.

Starting from the reports on Index Composition - where J.P. Morgan conveys information on *benchmark weights* and market capitalization for each of the country in the GBI EM Global Diversified - we construct a dataset containing the time-series (from September 2009 to March 2016) of the weights assigned to each of the 16 emerging countries included in the Index, namely: Brazil, Chile, Colombia, Hungary, Indonesia, Malaysia, Mexico, Nigeria, Peru, Philippines, Poland, Romania, Russia, South Africa, Thailand and Turkey. After merging this information with the data on the value of the assets benchmarked to the Index, we use the methodology described in the previous section to calculate the monthly, country-specific, time-series of Flows Implied by Rebalancing (FIR), that is, our main independent variable.

For each of country in the Index, we search Bloomberg to collect the ISIN of all the sovereign bonds issued before or during the sample period. Starting from the list of ISIN, we download from Datastream the static information relative to each bond, that is, the issuance and the maturity dates, the issuance price, the currency, the issuer type and the bond type. We use such information to identify all sovereign debt straight bonds in local currency with at least one year of life to maturity at issuance. For these bonds, we then collect the time-series of bid, ask and mid prices.

Regarding prices, Datastream provides two distinct ask, bid and mid quotes: the *Thomson Reuters Composite* price and the *Thomson Reuters Pricing Service (TRPS)* one. While the first is an average price from all the available key market contributors, the second one is the price as evaluated by the Fixed Income Pricing Service team at Thomson Reuters.[22] To summarize the information conveyed by each of the two sources in a single variable, we compute the average of the daily Composite and TRPS mid-prices and we label this variable "Price". Similarly, after computing the absolute spread as the difference between the ask and the bid quote, for each of the two price sources, and dropping from the sample all the observations with negative absolute bid-ask spread or with relative spread larger than 20%, we take the average between the TRPS and the Composite absolute spread and we define it as our "Spread", that is, our measure of the liquidity of the sovereign debt markets.

Starting from this panel containing the time-series of prices and bid-ask spreads, we compute cumulative returns around each rebalancing date, *i.e.* d, by taking the difference between the log of Price in $d - 5$, that is, five days before the rebalancing date, and the log of Price z days after the rebalancing date.[23] Similarly, we measure the percentage change in the liquidity of the market z days after the rebalancing as the difference in the log of Spread in $d + z$ and $d - 5$. To clean our dataset, we finally exclude from the analysis: i) bonds with more than 90% of zero-changes in the price from one day to the subsequent one since these are

[22]The composite price is exactly equal to the average quote when contributors are 1 or 2. With 3 contributors, the contributor with the most extreme quote is excluded and the composite price equals the average between the two remaining quotes. Finally, when there are more than 4 contributors, the highest and the lowest quotes are excluded before calculating the average one. As regards TRPS prices, these are provided daily by the Reuters Evaluated Pricing Service through evaluation models combining bond characteristics, pricing models and real-time dealer quotes, electronically obtained from market contributors.

[23]The rebalancing date in a given month coincides with the last trading day of the month until October 2013 and the first day of the subsequent month afterwards.

mainly bonds that were never traded; ii) bonds maturing in less than one year, since these are also excluded from the Index; iii) bonds traded after the maturity date.

As a result, we end up with a panel containing data on 623 bonds issued by the governments of 15 countries and around 19K bond-month specific observations. In particular, the final dataset has the following structure: for each of the bond in the sample, we have, for each rebalancing date, the change in the log of the price (or the spread) between five days prior to the rebalancing and ten days after it. The summary statistics relative to the bonds in our sample are reported in Panel A of Table 2.1, as well as in Panel A of Table 2.2, where means are computed for each of the 15 countries in the sample, separately.[24]

Additionally, we retrieve from Datastream the time-series of daily exchange rates, for each of the 16 countries in the sample. The exchange rate is the amount of local currency needed to buy a US dollar, so that a decrease in the exchange rate reflects an appreciation of the local currency. As with the price information, we define the log change in the exchange rate z days after (or before) the rebalancing as the difference between the log of the exchange rate in day $d + z$ and the one in $d - 5$. Summary statistics on exchange rates, as well as on Market capitalization and FIR - that also vary at the country level - are reported in Panel B of Table 2.1 and Table 2.2.

Finally, we exclude from the analysis those months in which there were extremely large rebalancing events, as for instance the upgrades of Colombia, Nigeria and Romania, and the downgrade of Nigeria.[25] The rationale for this choice is that, when rebalancings are particularly relevant, J.P. Morgan already announces them in the middle of the month, or even before, and - given our identification strategy - we only focus on cases in which the rebalancing takes place at the end of the month and is contemporaneous to the announcement made by J.P. Morgan.

[24] In the regressions on Price and Spread, we only have 15 of the 16 countries in the Index since we could not get daily prices for Chilean bonds.

[25] Similarly, we exclude the top and the bottom 1% in the distribution of FIR.

2.3.2. Main Results

Table 2.3 presents the main results for sovereign bond prices. Columns 1 to 3 (with time fixed effects) show that FIR is positively associated with the cumulative returns of government bond prices, and the relationship is statistically significant at the 1 percent level. We start by estimating this relationship for cumulative returns from $d - 5$ to $d + 3$ (Column 1) and then we extend it to $d + 5$ (Column 2) and $d + 7$ (Column 3). In all of these cases, the coefficient is relatively stable, and is statistically significant even 7 days after the day of the rebalancing. The results are very similar when we control for the years to maturity of the bonds in the sample (Columns 4 to 6), and when we include country fixed effects (Columns 7 to 9), thus showing that FIR not only explains the across-country variation of returns, but also the within-country one.

Quantitatively, these results in line with some of the big episodes of rebalancings in the J.P. Morgan GBI-EM Global Diversified. A one-standard-deviation increase in FIR (0.875 percentage points) leads to an average increase in sovereign debt prices of 8 basis points in the symmetrical window from $d - 5$ to $d + 5$. While this number seems low, it is consistent with large episodes of rebalancings, as for instance the inclusion of five Colombian treasury securities in March 2014. The estimated FIR for that episode was around 22.3 percent.[26] Multiplying this number by the coefficient in Table 3, Column 2, we have an estimated average cumulative return of 2 percent. Actually, the average cumulative returns for sovereign bonds in the local currency bond market in Colombia was 2.2 percent for the window from $d-5$ to $d+5$.[27] Thus, our estimates are consistent with these big rebalancing episodes and can be quantitatively important for the countries in our sample.

To estimate the impact of informationless flows on liquidity, we perform a similar estimation using as dependent variable the cumulative change in the log of the bid-ask spread of sovereign bonds (Table 2.4). FIR is negatively associated with the cumulative percentage changes in the bid-ask spread, thus showing that

[26]For this estimated FIR we take the average of the market value before and after the rebalancing because of the large differences in market value after the inclusion of the colombian sovereign bonds in the index.

[27]For more details on this inclusion episode, see Williams (2017).

informationless flows are positively associated with sovereign debt liquidity in the cross section (Column 1). This result, however, is statistically significant only in our shortest window. This suggests that the effect on liquidity is more transitory than the one for prices. As regards the magnitude of the estimated coefficient, a one-standard-deviation increase in FIR leads to a decrease of 1.02 percentage points in the bid-ask spread, meaning that a large event as the inclusion of the Colombian bonds in 2014 would produce a decrease in the spread approximately equal to 25 percentage points.

Since the FIR variable captures uninformed capital flows into the local-currency sovereign debt market, we are also interested on the potential spillovers to the exchange rate market. If an international mutual fund has to direct capital inflows (outflows) to the local sovereign debt market as a consequence of the rebalancings, it will typically need to buy (sell) local currency in exchange for foreign currency (commonly, U.S. dollars). Therefore, our FIR measure might also predict the cross-section of returns in the exchange rate market. Our results in Table 2.5 confirm this hypothesis. In this table we regress the cumulative returns of the exchange rate (in local currency per U.S. dollar) on FIR and show that they are negatively associated with FIR.[28] The coefficients are stable across the different windows used (Columns 1 to 3), when we add country fixed effects (Columns 4 to 6), and when we cluster standard errors at the country-year level. Furthermore, the results are larger than those for sovereign bond prices. A one standard deviation increase in FIR is associated with an appreciation of 32 basis points in the exchange rate, consistently with the higher volatility in the exchange rate market compared to the sovereign debt market.

2.3.3. Placebo Tests

Our identification relies on two main hypothesis: i) international mutual funds do not want to deviate far away from the benchmark they track and thus rebalance their portfolio when the index do so; ii) our measure of informationless capital flows is actually capturing flows purely driven by the mechanical rebalancings

[28] As our measure of exchange rate is in local currency per U.S. dollar an increase in it signals a depreciation and a decrease in the measure shows an appreciation of the currency.

made by J.P. Morgan to comply with the 10% cap rule and are not driven by new information about the future macroeconomic conditions of the countries in the index. To test whether these two hypothesis hold in our dataset, in this section we perform a sort of placebo tests by looking at the correlation between our dependent variables and FIR on a day-by-day basis around the rebalancing dates. Under our identification hypothesis, we should observe that this relationship only becomes significant following the rebalancings. Therefore, we regress FIR on the changes in price, liquidity and exchange rate from $d-4$ to $d+4$, where d is the rebalancing date. As long as mutual funds following the index do not anticipate rebalancings and FIR is not systematically correlated with unobservables at the country-month level that also affect our dependent variables, we expect the coefficients from $d-4$ to d to be not statistically different from zero.

Our results show that after the rebalancing there is a strong increase in the relationship between FIR and the cumulative returns of sovereign bonds (Table 2.6). The coefficient between $d-4$ and d is very close to zero in magnitude and not statistically significant. In $d+1$ we already observe an increase in the coefficient which increases almost by four times, though it is not statistically significant. from $d+2$ to $d+4$ the β coefficient keeps increasing and is always significant at the 1 percent confidence level. A very similar picture arises when we look at the results for the bid-ask spread (Table 2.7). The β is statistically (and in magnitude) not different from zero before the date of the rebalancing. This changes importantly both at d and afterwards when we observe an increase in the absolute value of the coefficient. From d to $d+4$, β is negative and statistically significant. This implies that a higher FIR is associated with a higher liquidity in the sovereign debt market after the rebalancing dates. For the exchange rate, the results are qualitatively similar (Table 2.8). We have very low negative coefficients before d with some values significant at the 5 percent level. But more importantly, from d onwards, the coefficient is much larger in absolute value, double in size than the one before, and significant at the 1 percent level. These placebo tests lend important support to our identification strategy.

2.3.4. Additional Results

We also conduct additional tests to further explore potential heterogeneity in our results. For instance, we divide our sample into government bonds that are included in the J.P. Morgan GBI-EM Global Diversified versus bonds that are not. Results for sovereign bond prices (Table 2.9, Columns 1 to 6) show that the impact of FIR is larger both in size and statistical significance for bonds that are part of the index. This result is not surprising, since the rebalancings affect these bonds, hence the higher reaction of their prices. Our results are somewhat different for the liquidity of these bonds (Table 2.10, Columns 1 to 6). In this case, a larger FIR is associated with a higher liquidity, and this relationship is stronger for bonds that are not part of the index. This could be due to the fact that bonds that are not in the index are usually less liquid (that is exactly the reason why they are not included in the index). Thus, the effect of FIR on liquidity might be larger and more long-lasting for bonds that are less liquid, while being only temporary for bonds already characterized by a relatively small spread.

Furthermore, we analyze whether our results hold at the country-maturity level. We collapse both our dependent variables for prices and liquidity at the country-time-to-maturity-level, where time-to-maturity are dummies that indicate whether a bond is maturing in 1 to 3, 3 to 5, 5 to 7, 7 to 10 or more than 10 years. Both for sovereign bond prices and liquidity the results are very similar to our main specification, showing that individual bonds in countries are not distorting our coefficients (Tables 2.9 and 2.10, Columns 7 to 9).

Moreover, we analyze three additional dimensions of heterogeneity for our main specifications. First, we look at the potential differences in negative and positive informationless capital flows, by estimating the coefficient of FIR conditional on its sign. (Table 2.11, top panel). For both sovereign debt prices and exchange rates, there does not seem to be an asymmetry, as the coefficients are not statistically different. Instead, for liquidity, only the inflows of capital seems to improve liquidity. Second, we divide our sample into three different time periods, 2009-2011, 2012-2014, 2015-2016 (Table 2.11, mid panel). The β for our three dependent variable is much stronger for the middle and (somewhat) later period in our sample. This is consistent with two facts: first, international mutual funds investing in local currency sovereign debt in emerging markets have become larger in size; second, there has been a rise in passive funds, meaning more benchmarking. Third, we split our sample of bonds according to their maturity into short-term (1 to 5 years of maturity), medium-term (5 to 10 years of maturity) and long-term (more than 10 years of maturity (Table 2.11, bottom panel). The effects from uninformed flows on prices appear to be stronger for long-term government bonds, coherently with the fact the the price of bonds maturing in the short-term is less volatile than the one of long-term bonds. Instead, the effects on liquidity are very similar for the different maturities.

2.4. Implications

Our results show that capital inflows (outflows), even when uninformative, increase (decrease) the prices of sovereign bonds, improve (decrease) the liquidity in the sovereign debt market, and also appreciate (depreciate) the exchange rate. Given our identification strategy, we can only look at a few days back or after the rebalancings (in our case 5 and 7). Thus, we only capture temporary relationships that are also somewhat small due to our daily frequency. As a result, it is very difficult to gauge the impact of these capital flows (through the sovereign debt market) on real economic activity. However, our results, especially on sovereign debt prices and exchange rates, extend at least to seven days after the rebalancings. In this section we discuss the potential implications of these results, if these effects were to be permanent.

Both sovereign bond prices and the exchange rate are asset prices central to the macroeconomy. The sovereign bond prices are inversely related to government bond yields. Thus, our results suggest that capital flows might affect permanently (or at least for a reasonable amount time) the cost of capital for governments in emerging markets. This might lead to a variation in the amount of debt a government might want to issue, and may end up affecting government expenditure. In the end, one implication of the results in this paper is that even informationless capital flows to the sovereign debt market can have important effects on the economic cycles in emerging markets through government expenditures.

Even if the government did not react to the increase (decrease) of government bond yields due to capital inflows (outflows), there could be other potential channels impacting the real economy. For instance, the transmission mechanism could go through financial institutions. As capital flows have an impact on the price of sovereign debt, they can affect the balance sheet of these institutions as well. In emerging markets, these financial institutions, mainly banks, hold a sizable amount of government bonds. As their price increase, and their balance sheet consequently improves, banks may be able to increase their supply of credit, thus fostering economic activity (and vice versa, in case of capital outflows). This valuation channel might be exacerbated by changes in the exchange rate. As banks hold also a good amount of assets and liabilities denominated in foreign currency, uninformed capital flows might have an impact on the health of the balance sheet through the exchange rate as well.

Finally, the exchange rate (absent any intervention from the central bank or the government) might have an effect on its own on the macroeconomy. As uninformed capital flows affect exchange rates, they consequently have an impact on the competitiveness of the country and therefore on net exports. When this channel is at work, informationless inflows (outflows) might decrease (increase) economic activity.

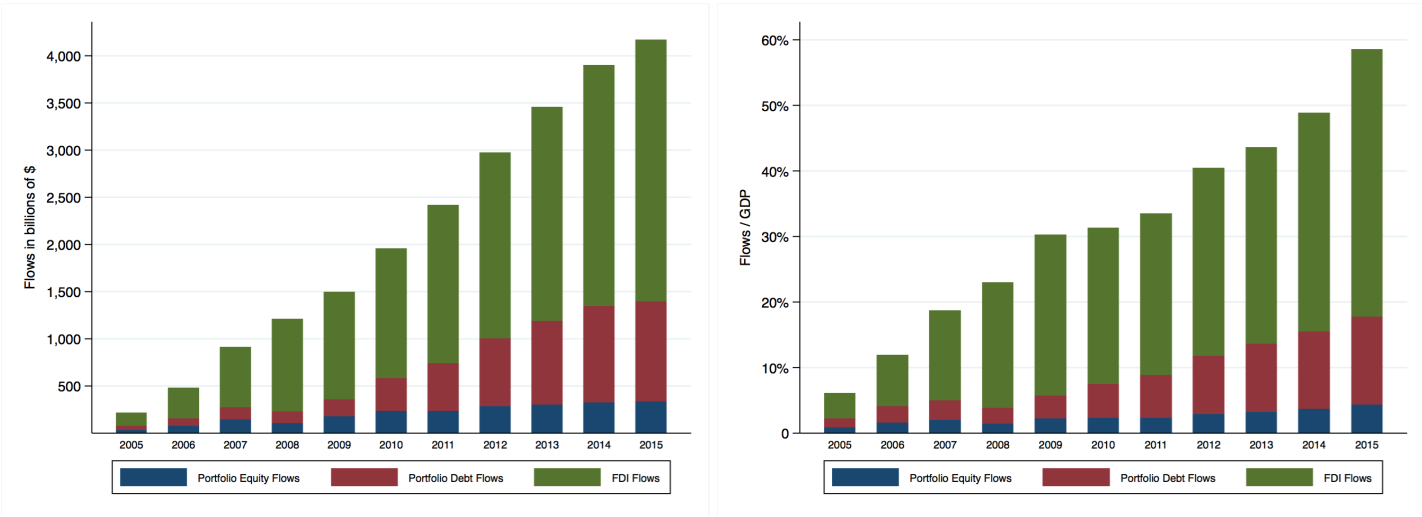
2.5. Conclusion

This paper analyze the effect of informationless capital flows on the sovereign bond market in emerging markets, and their spillovers to the exchange rate markets. In principle, it is not clear whether these flows should affect the prices and liquidity in these markets. To test whether this is the case, we use a novel identification strategy based on the index rebalancings of a major index of local currency government debt in emerging markets. We construct a measure of the capital flows implied by these rebalancings (FIR) that is in principle uninformative and not driven by the economic conditions in these emerging markets.

Our results show that FIR is positively correlated with both the returns and the liquidity in the sovereign debt markets of emerging economies. Moreover, the effects of these uninformed capital flows spill over to the exchange rate market. The estimated effects are consistent with episodes of large capital flows in the sovereign debt market. More importantly, we present evidence that in the days prior to the rebalancing, the relationship between FIR and prices, liquidity and the exchange rate is close to zero, and only becomes sizeable and statistically significant after the rebalancing dates, thus confirming the informationless nature of our measure of rebalancing-driven flows.

As both the sovereign debt prices and exchange rate are central asset prices for the macroeconomy, our results suggest a broader impact of uninformed capital flows to the sovereign debt market.

Figure 2.1: Gross Liability Flows



Absolute

Relative to GDP

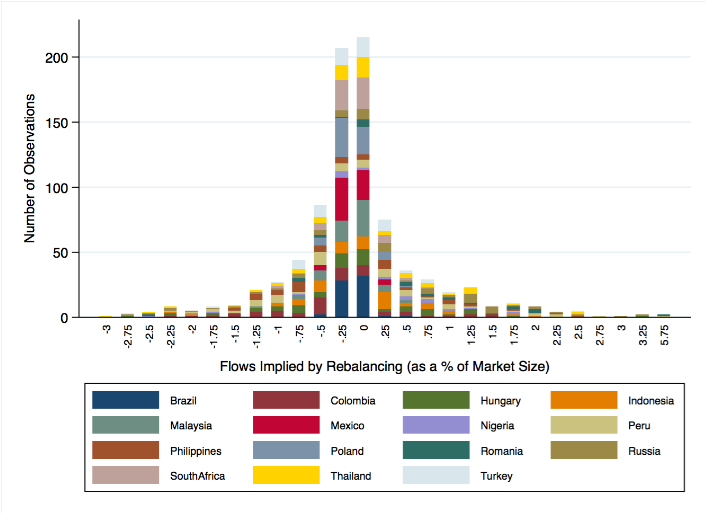
Note: This figure plots the cumulative gross liability flows to emerging markets, divided by the type of assets. The left panel presents the sum of all gross inflows to emerging markets (in Billions of U.S. dollars). The right panel depicts the gross inflows as a percentage of GDP and is created by computing the cumulative flows over GDP for each country and then averaging across countries in each year. The countries included in the sample are: Brazil, Chile, Colombia, Hungary, Indonesia, Mexico, Peru, Philippines, Poland, Romania, Russia, South Africa, Thailand and Turkey.

Figure 2.2: Price, Liquidity and FX around the Rebalancing date

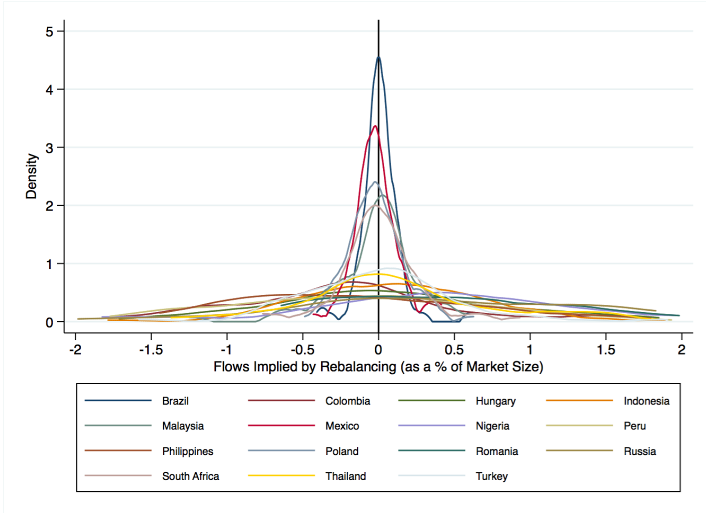
Price   Spread   Exchange Rate

Note: The three figures represent the trend of average difference between the log of Price, bid-ask Spread and Exchange rate and the log of each of the three variable five days prior to the rebalancing date, for observations in the first and the last decile of the distribution of Flows Implied by the Rebalancing.

Figure 2.3: Distribution of Flows Implied by Rebalancing



Histogram



Kernel density

Note: This figure depicts the distribution of FIR across countries. In the left panel, each bin in the histogram contains the number of month-specific observations, both aggregate and by country, for which the FIR is included in the interval whose lower bound is on the x axis. The right panel shows the Kernel density estimate of the country-specific distribution of the FIR measure.

Table 2.1: Summary Statistics

	Mean	Sd	Min	Median	Max
Panel A: Bond level summary statistics					
Δlog(Price)$_3$	-0.01	1.32	-11.6	0.00	10.2
Δlog(Price)$_5$	-0.03	1.50	-14.2	0.00	11.0
Δlog(Price)$_7$	-0.05	1.69	-18.3	0.00	11.9
Relative bid-ask Spread	0.01	0.01	0.0	0.00	0.2
Δlog(Spread)$_3$	-1.07	34.42	-624.6	0.00	552.5
Δlog(Spread)$_5$	-0.66	35.85	-583.5	0.00	621.7
Δlog(Spread)$_7$	-0.72	35.53	-579.4	0.00	621.7
Years to Maturity	8.64	7.32	1.0	6.28	50.4
Years of Life	4.73	3.39	0.0	4.09	22.6
Panel B: Country level summary statistics					
FIR	0.05	0.87	-2.8	0.00	5.9
Δlog(FX rate)$_3$	0.14	2.10	-6.4	-0.02	15.7
Δlog(FX rate)$_5$	0.16	2.30	-6.0	-0.02	14.1
Δlog(FX rate)$_7$	0.29	2.51	-10.7	-0.01	16.8
Total Market Value in US $	63.79	54.12	1.1	52.74	261.9
Weight in the Index	7.35	3.38	0.2	9.60	10.0

Note: $\Delta\log(y)_z$ is the cumulative log change of y over an interval that goes from 5 days prior to the rebalancing date to z days after it. The average of the relative bid-ask spread is computed in $d-5$, that is, 5 days before the rebalancing. Statistics in Panel A are calculated on the whole sample of bonds used in the main regressions on Price and Spread, that includes 15 of the 16 countries in the Index. The statistics in Panel B are computed on the whole population of country, including Chile, that is not present in the bond-level panel.

Table 2.2: Summary Statistics by country

	Brazil	Colombia	Hungary	Indonesia	Malaysia	Mexico	Nigeria	Peru	Philip-pines	Poland	Romania	Russia	S. Africa	Thailand	Turkey
Panel A: Bond level summary statistics, by country															
Δlog(Price)$_3$	-0.30	-0.05	-0.01	-0.12	0.01	-0.09	-0.10	-0.21	0.11	-0.03	-0.01	0.05	-0.06	0.06	0.01
Δlog(Price)$_5$	-0.24	-0.03	0.06	-0.27	-0.01	0.04	-0.13	-0.28	0.10	-0.02	-0.04	0.00	-0.07	0.03	-0.03
Δlog(Price)$_7$	-0.20	-0.06	0.06	-0.39	-0.02	0.06	-0.29	-0.26	0.16	-0.02	-0.01	-0.05	-0.06	-0.02	-0.10
Relative bid-ask Spread	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.01
Δlog(Spread)$_3$	0.66	-0.28	-3.07	0.73	-1.52	-0.62	4.49	-0.75	-2.39	2.39	-0.76	-1.48	-1.04	-2.05	-2.23
Δlog(Spread)$_5$	0.25	0.26	-2.62	3.11	0.42	2.01	0.81	-0.94	-2.28	0.54	-2.59	-1.08	-1.01	-2.50	-2.94
Δlog(Spread)$_7$	-0.06	-0.43	-3.81	2.72	0.97	-0.23	0.08	-1.52	-2.24	0.24	-1.67	1.81	-0.18	-2.42	-3.69
Years to Maturity	8.24	7.95	7.61	11.60	9.59	10.43	7.71	15.82	9.66	8.49	5.04	6.69	15.04	10.80	6.45
Years of Life	2.31	2.54	2.04	3.10	2.34	3.09	2.89	3.12	3.77	1.97	3.74	0.51	3.99	3.13	-0.88
Panel B: Country level summary statistics, by country															
FIR	0.01	-0.23	-0.01	0.10	-0.03	-0.01	0.24	0.12	-0.02	-0.02	0.69	0.39	0.00	0.09	-0.00
Δlog(FX rate)$_3$	0.33	0.04	0.45	0.48	-0.16	-0.05	0.26	0.07	-0.25	0.21	0.30	0.83	-0.13	0.02	0.26
Δlog(FX rate)$_5$	0.27	0.03	0.39	0.47	-0.08	-0.02	0.36	0.04	-0.19	0.11	0.41	1.04	-0.04	0.09	0.18
Δlog(FX rate)$_7$	0.38	-0.11	0.60	0.87	-0.03	0.18	0.75	0.01	-0.14	0.41	0.24	1.17	0.43	0.06	0.37
Total Market Value in US $	201.28	29.51	32.76	51.19	67.56	135.61	11.66	10.09	2.73	100.85	13.67	40.18	74.90	47.29	59.68
Weight in the Index	10.00	4.83	6.34	9.20	9.98	10.00	1.82	1.91	0.47	10.00	2.12	7.13	9.96	8.49	9.88
Panel C: Average Number of bonds observed in each period, by years to maturity															
1 to 3 years to maturity	1.56	3.39	4.48	6.11	8.27	4.09	1.25	1.89	11.52	3.23	2.78	7.30	2.02	10.28	4.27
3 to 5 years to maturity	1.34	2.94	2.97	3.47	6.31	3.48	1.38	1.45	9.58	3.61	1.73	4.23	1.80	6.50	2.98
5 to 7 years to maturity	1.02	1.88	1.92	2.77	4.80	1.75	0.52	1.64	7.30	1.66	1.56	1.83	1.41	3.91	0.52
7 to 10 years to maturity	1.61	2.19	2.19	4.78	3.91	2.28	0.44	3.08	9.52	2.42	0.80	1.52	1.95	5.00	2.55
More than 10 years to maturity	1.88	3.38	2.19	14.67	8.98	6.63	1.59	10.42	20.33	3.42	0.50	1.48	5.98	12.11	0.00
Total	7.41	13.78	13.75	31.8	32.27	18.23	5.18	18.48	58.25	14.34	7.37	16.36	13.16	37.8	10.32

Note: $\Delta\text{log(y)}_z$ is the cumulative log change of y over an interval that goes from 5 days prior to the rebalancing date to z days after it. The average of the relative bid-ask spread is computed in $d-5$, that is, 5 days before the rebalancing. Statistics in Panel A are calculated on the whole sample of bonds used in the main regressions on Price and Spread, for each of the 15 countries used in the analysis, separately. Chile is omitted from the table due to bond data availability. As regards country-level data, the average FIR in Chile is equal to $-.10$; the average $\Delta\text{log(FX rate)}_z$ is $-.15$, $-.20$ and $-.13$ for z equal to 3, 5 and 7, respectively. The average market value is US$ is 1.12 and the average weight in the GBI EM Global diversified equals $.19$.

Table 2.3: Effects of Flow Implied by Rebalancing on Bond Prices

Dependent Variable: Cumulative Returns									
	Time FE			Time FE & Controls			Country and Time FE		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$[d+3]$	$[d+5]$	$[d+7]$	$[d+3]$	$[d+5]$	$[d+7]$	$[d+3]$	$[d+5]$	$[d+7]$
FIR	0.088***	0.090***	0.113***	0.089***	0.091***	0.113***	0.089***	0.096***	0.123***
	(0.021)	(0.024)	(0.034)	(0.021)	(0.024)	(0.034)	(0.023)	(0.025)	(0.035)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	No	No	No	No	No	Yes	Yes	Yes
Controls	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Mean Indep. Var.	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
Standard dev.	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875
Observations	19101	19087	19077	19101	19087	19077	19101	19087	19077
N. of Countries	15	15	15	15	15	15	15	15	15
N. of Bonds	623	623	623	623	623	623	623	623	623
R^2	0.177	0.210	0.233	0.177	0.210	0.233	0.184	0.219	0.244

Note: The Table reports the OLS coefficients of FIR on cumulative returns in a period that starts 5 days before the rebalancing and ends 3, 5 and 7 days after it. Controls include bonds' life to maturity, that is measured using a set of dummies identifying bonds with maturity between 1 and 3 years, 3 and 5 years, 5 and 7 years, 7 to 10 years, and more than 10 years. Chile is excluded by the regression due to data availability. The main independent variable is the FIR measure computed following equation (3.2). Standard errors in parenthesis are clustered by country and years to maturity (following the categories described above). *** $p < 0.01$, ** $p < 0.05$, *$p < 0.10$.

Table 2.4: Effects of Flow Implied by Rebalancing on the Bid-Ask Spread

Dependent Variable: Δ log(Bid-Ask Spread)									
	Time FE			Time FE & Controls			Country and Time FE		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$[d+3]$	$[d+5]$	$[d+7]$	$[d+3]$	$[d+5]$	$[d+7]$	$[d+3]$	$[d+5]$	$[d+7]$
FIR	-1.175***	-0.456	-0.493	-1.149***	-0.426	-0.462	-1.294***	-0.447	-0.602*
	(0.353)	(0.299)	(0.318)	(0.354)	(0.297)	(0.327)	(0.359)	(0.318)	(0.322)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	No	No	No	No	No	Yes	Yes	Yes
Controls	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Mean Indep. Var.	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
Standard dev.	0.872	0.872	0.872	0.872	0.872	0.872	0.872	0.872	0.872
Observations	18826	18800	18769	18826	18800	18769	18826	18800	18769
N. of Countries	15	15	15	15	15	15	15	15	15
N. of Bonds	618	618	618	618	618	618	618	618	618
R^2	0.036	0.031	0.044	0.036	0.032	0.045	0.038	0.035	0.048

Note: The Table reports the OLS coefficients of FIR on the change in the log of the bid-ask spread in a period that starts 5 days before the rebalancing and ends 3, 5 and 7 days after it. Controls include bonds' life to maturity, that is measured using a set of dummies identifying bonds with maturity between 1 and 3 years, 3 and 5 years, 5 and 7 years, 7 to 10 years, and more than 10 years. Chile is excluded by the regression due to data availability. The main independent variable is the FIR measure computed following equation (3.2). Standard errors in parenthesis are clustered by country and years to maturity (following the categories described above). *** $p< 0.01$, ** $p< 0.05$, *$p< 0.10$.

Table 2.5: Effects of Flow Implied by Rebalancing on the Exchange Rate

Dependent Variable: Δ log(FX Rate)

	Time FE			Time & Country FE			Clustered SE		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$[d+3]$	$[d+5]$	$[d+7]$	$[d+3]$	$[d+5]$	$[d+7]$	$[d+3]$	$[d+5]$	$[d+7]$
FIR	-0.325***	-0.364***	-0.367***	-0.359***	-0.413***	-0.424***	-0.359***	-0.413***	-0.424***
	(0.091)	(0.097)	(0.110)	(0.096)	(0.099)	(0.115)	(0.109)	(0.131)	(0.143)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Mean Indep. Var.	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049
Standard dev.	0.879	0.879	0.879	0.879	0.879	0.879	0.879	0.879	0.879
Observations	876	878	877	876	878	877	876	878	877
N. of Countries	16	16	16	16	16	16	16	16	16
R^2	0.438	0.451	0.421	0.462	0.478	0.451	0.462	0.478	0.451

Note: The Table reports the OLS coefficients of FIR on the change in the log of the exchange rate in a period that starts 5 days before the rebalancing and ends 3, 5 and 7 days after it. The main independent variable is the FIR measure computed following equation (3.2). Robust standard errors in parenthesis in columns (1)-(6), and standard errors clustered at the country-year level in columns (7)-(9). *** $p < 0.01$, ** $p < 0.05$, *$p < 0.10$.

Table 2.6: Cumulative Returns around the Rebalancing date

Dependent Variable: Cumulative Returns									
	Pre-rebalancing				Rebalancing	Post-rebalancing			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$[d-4]$	$[d-3]$	$[d-2]$	$[d-1]$	d	$[d+1]$	$[d+2]$	$[d+3]$	$[d+4]$
FIR	0.011	0.001	0.011	0.014	0.007	0.027	0.064***	0.089***	0.098***
	(0.009)	(0.012)	(0.013)	(0.017)	(0.018)	(0.018)	(0.018)	(0.021)	(0.022)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean Indep. Var.	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
Standard dev.	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875
Observations	19101	19101	19101	19101	19101	19101	19101	19101	19092
N. of Countries	15	15	15	15	15	15	15	15	15
N. of Bonds	623	623	623	623	623	623	623	623	623
R^2	0.055	0.096	0.114	0.128	0.152	0.154	0.159	0.177	0.190

Note: The Table reports the OLS coefficients of FIR on cumulative returns, computed as the difference between the log of Price in $d-5$, where d is the rebalancing date, and the log of Price in the days around the rebalancing. Controls include bonds' life to maturity, that is measured using a set of dummies identifying bonds with maturity between 1 and 3 years, 3 and 5 years, 5 and 7 years, 7 to 10 years, and more than 10 years. Chile is excluded by the regression due to data availability. The main independent variable is the FIR measure computed following equation (3.2). Standard errors in parenthesis are clustered by country and years to maturity (following the categories described above). *** p< 0.01, ** p< 0.05, *p< 0.10.

Table 2.7: Change in the Spread around the Rebalancing date

Dependent Variable: Δ log(Bid-Ask Spread)									
	Pre-rebalancing				Rebalancing	Post-rebalancing			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$[d-4]$	$[d-3]$	$[d-2]$	$[d-1]$	d	$[d+1]$	$[d+2]$	$[d+3]$	$[d+4]$
FIR	-0.024	0.132	0.024	-0.116	-0.425	-0.640**	-0.810**	-1.149***	-0.702**
	(0.256)	(0.263)	(0.350)	(0.243)	(0.311)	(0.314)	(0.352)	(0.354)	(0.340)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean Indep. Var.	0.056	0.056	0.056	0.056	0.056	0.057	0.057	0.058	0.058
Standard dev.	0.873	0.873	0.873	0.873	0.873	0.872	0.873	0.872	0.872
Observations	18839	18843	18836	18845	18839	18836	18803	18826	18815
N. of Countries	15	15	15	15	15	15	15	15	15
N. of Bonds	618	618	618	618	618	618	618	618	618
R^2	0.008	0.006	0.005	0.043	0.040	0.039	0.039	0.036	0.047

Note: The Table reports the OLS coefficients of FIR on on the change in the log of the bid-ask spread, computed as the difference between the log of Spread in $d-5$, where d is the rebalancing date, and the log of Spread in the days around the rebalancing. Controls include bonds' life to maturity, that is measured using a set of dummies identifying bonds with maturity between 1 and 3 years, 3 and 5 years, 5 and 7 years, 7 to 10 years, and more than 10 years. Chile is excluded by the regression due to data availability. The main independent variable is the FIR measure computed following equation (3.2). Standard errors in parenthesis are clustered by country and years to maturity (following the categories described above). *** p< 0.01, ** p< 0.05, *p< 0.10.

Table 2.8: Change in the Exchange Rate around the Rebalancing date

Dependent Variable: Δ log(FX Rate)									
	Pre-rebalancing				Rebalancing	Post-rebalancing			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$[d-4]$	$[d-3]$	$[d-2]$	$[d-1]$	d	$[d+1]$	$[d+2]$	$[d+3]$	$[d+4]$
FIR	-0.035	-0.064*	-0.067	-0.116**	-0.238***	-0.280***	-0.299***	-0.325***	-0.358***
	(0.030)	(0.038)	(0.045)	(0.054)	(0.068)	(0.076)	(0.088)	(0.091)	(0.103)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean Indep. Var.	0.048	0.048	0.049	0.049	0.046	0.049	0.050	0.049	0.049
Standard dev.	0.878	0.878	0.878	0.878	0.876	0.879	0.879	0.879	0.879
Observations	877	877	879	879	877	875	876	876	878
N. of Countries	16	16	16	16	16	16	16	16	16
R^2	0.331	0.422	0.362	0.406	0.412	0.417	0.413	0.438	0.439

Note: The Table reports the OLS coefficients of FIR on the change in the log of the exchange rate, computed as the difference between the log of the exchange rate in$d-5$, where d is the rebalancing date, and the log of the exchange rate in the days around the rebalancing. The main independent variable is the FIR measure computed following equation (3.2). Robust standard errors in parenthesis. *** $p< 0.01$, ** $p< 0.05$, *$p< 0.10$.

Table 2.9: Effects of Flow Implied by Rebalancing on Bond Prices (additional results)

Dependent Variable: Cumulative Returns	Bonds in the Index			Bonds not in the Index			Country Level		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$[d+3]$	$[d+5]$	$[d+7]$	$[d+3]$	$[d+5]$	$[d+7]$	$[d+3]$	$[d+5]$	$[d+7]$
FIR	0.099***	0.138***	0.185***	0.072***	0.061**	0.070*	0.092***	0.101***	0.117***
	(0.026)	(0.036)	(0.056)	(0.025)	(0.029)	(0.036)	(0.022)	(0.025)	(0.039)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean Indep. Var.	0.042	0.042	0.042	0.069	0.069	0.069	0.046	0.046	0.046
Standard dev.	0.786	0.786	0.786	0.930	0.929	0.929	0.822	0.822	0.822
Observations	7569	7568	7566	11532	11519	11511	3986	3985	3985
N. of Countries	15	15	15	15	15	15	15	15	15
N. of Bonds	222	222	222	401	401	401			
R^2	0.256	0.283	0.298	0.163	0.197	0.223	0.224	0.255	0.279

Note: The Table reports the OLS coefficients of FIR on cumulative returns in a period that starts 5 days before the rebalancing and ends 3, 5 and 7 days after it. Controls include bonds' life to maturity, that is measured using a set of dummies identifying bonds with maturity between 1 and 3 years, 3 and 5 years, 5 and 7 years, 7 to 10 years, and more than 10 years. In columns (1)-(3) estimates are computed on the subsample of bonds included in the GBI EM Global Diversified. Sovereign debt straight bonds in local currency not in the index constitute the subsample used in columns (4)-(6). Finally, in the last three columns, estimates are produced after collapsing data by country, time and years to maturity (following the above mentioned 5 categories). Chile is excluded by the regression due to data availability. The main independent variable is the FIR measure computed following equation (3.2). Standard errors in parenthesis are clustered by country and years to maturity. *** p< 0.01, ** p< 0.05, *p< 0.10.

Table 2.10: Effects of Flow Implied by Rebalancing on the Bid-Ask Spread (additional results)

Dependent Variable: Δ log(Bid-Ask Spread)

	Bonds in the Index			Bonds not in the Index			Country Level		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$[d+3]$	$[d+5]$	$[d+7]$	$[d+3]$	$[d+5]$	$[d+7]$	$[d+3]$	$[d+5]$	$[d+7]$
FIR	-1.128**	0.056	0.112	-1.367***	-1.192***	-1.199***	-1.288***	-0.212	-0.104
	(0.472)	(0.376)	(0.433)	(0.429)	(0.376)	(0.407)	(0.463)	(0.339)	(0.393)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean Indep. Var.	0.039	0.039	0.039	0.070	0.070	0.071	0.043	0.043	0.044
Standard dev.	0.784	0.784	0.784	0.925	0.925	0.925	0.820	0.820	0.819
Observations	7502	7500	7493	11324	11300	11276	3959	3958	3956
N. of Countries	15	15	15	15	15	15	15	15	15
N. of Bonds	222	222	222	396	396	396			
R^2	0.015	0.025	0.024	0.082	0.079	0.092	0.032	0.032	0.048

Note: The Table reports the OLS coefficients of FIR on the change in the log of the bid-ask spread in a period that starts 5 days before the rebalancing and ends 3, 5 and 7 days after it. Controls include bonds' life to maturity, that is measured using a set of dummies identifying bonds with maturity between 1 and 3 years, 3 and 5 years, 5 and 7 years, 7 to 10 years, and more than 10 years. In columns (1)-(3) estimates are computed on the subsample of bonds included in the GBI EM Global Diversified. Sovereign debt straight bonds in local currency not in the index constitute the subsample used in columns (4)-(6). Finally, in the last three columns, estimates are produced after collapsing data by country, time and years to maturity (following the above mentioned 5 categories). Chile is excluded by the regression due to data availability. The main independent variable is the FIR measure computed following equation (3.2). Standard errors in parenthesis are clustered by country and years to maturity (following the categories described above). *** $p< 0.01$, ** $p< 0.05$, *$p< 0.10$.

Table 2.11: Heterogeneity Analysis

Heterogeneous effects of FIR on Price, Liquidity and Exchange Rate									
	Cumulative Returns			Δ log(Bid-Ask Spread)			Δ log(FX Rate)		
	$[d+3]$	$[d+5]$	$[d+7]$	$[d+3]$	$[d+5]$	$[d+7]$	$[d+3]$	$[d+5]$	$[d+7]$
negative FIR × FIR	0.163***	0.137**	0.206**	-0.525	1.072	0.380	-0.724***	-0.801***	-0.740***
	(0.055)	(0.066)	(0.087)	(0.991)	(1.270)	(1.318)	(0.222)	(0.230)	(0.262)
positive FIR × FIR	0.177***	0.177***	0.207***	-1.435**	-1.007*	-1.411***	-0.231**	-0.214*	-0.226*
	(0.034)	(0.044)	(0.056)	(0.592)	(0.545)	(0.519)	(0.103)	(0.118)	(0.131)
2009-2011 × FIR	0.030	-0.010	0.032	-0.736	-0.728**	-0.761	-0.247*	-0.123	-0.100
	(0.037)	(0.039)	(0.050)	(0.580)	(0.346)	(0.631)	(0.139)	(0.137)	(0.143)
2012-2014 × FIR	0.119***	0.108***	0.143***	-1.410***	-0.298	-0.286	-0.311**	-0.305**	-0.376**
	(0.024)	(0.030)	(0.047)	(0.530)	(0.469)	(0.512)	(0.149)	(0.147)	(0.174)
2015-2016 × FIR	0.070	0.139***	0.116**	-0.906	-0.461	-0.610	-0.424**	-0.739***	-0.635***
	(0.045)	(0.042)	(0.050)	(0.595)	(0.666)	(0.674)	(0.165)	(0.196)	(0.237)
Long-Term × FIR	0.153***	0.156***	0.209***	-1.060**	-0.578	-0.827*			
	(0.030)	(0.032)	(0.050)	(0.464)	(0.407)	(0.448)			
Medium-Term × FIR	0.070**	0.078	0.083	-1.432*	-0.270	0.090			
	(0.029)	(0.051)	(0.075)	(0.780)	(0.794)	(0.927)			
Short-Term × FIR	0.032	0.031	0.029	-1.157**	-0.321	-0.262			
	(0.022)	(0.028)	(0.036)	(0.553)	(0.429)	(0.443)			
Observations	19101	19087	19077	18826	18800	18769	876	878	877

Note: The Table reports the OLS coefficients of FIR on the change in the log of Price, Spread and Exchange Rate in a period that starts 5 days before the rebalancing and ends 3, 5 and 7 days after it. All regressions include Time FE, and regressions on Price and Spread also include the usual controls on bonds' life to maturity. Chile is excluded by the sample in the regressions on Price and Spread. Positive (negative) FIR is a dummy variable that equals 1 when FIR is greater (smaller) than 0. 2009-2011, 2012-2014 and 2015-2016 are dummy variables that equal 1 when the observation is from a date included in the corresponding time interval. Long-Term is a dummy that equals 1 when the bond has less than 5 years of life to maturity; Medium-Term is a dummy that equals 1 when the bond has 5 to 10 years of life to maturity. Long-Term equals 1 when the bond matures in more than 10 years. The main independent variable is the FIR measure computed following equation (3.2). Standard errors in parenthesis are clustered by country and years to maturity (following the categories described above). *** $p< 0.01$, ** $p< 0.05$, *$p< 0.10$.

Chapter 3

FINANCIAL LITERACY AND ASSET EVALUATION: EVIDENCE FROM A LABORATORY EXPERIMENT

3.1. Introduction

In recent years, a growing emphasis is being placed on the role of financial literacy in individual decision-making. As long as agents are not fully rational or have limited understanding of financial markets, financial literacy potentially affects economic behavior in many ways.[1] In spite of its importance from a policy

[1]We refer to financial literacy as the level of understanding of basic financial concepts. Alternative and more complete definitions are given by Lusardi and Mitchell (2014) according to whom financial literacy is "peoples' ability to process economic information and make informed decisions about financial planning, wealth accumulation, debt, and pensions." (p.6). Similarly, Atkinson and Messy (2012) define it as "[...] a combination of awareness, knowledge, skill, attitude and behavior necessary to make sound financial decisions and ultimately achieve individual financial wellbeing." (p.14).

perspective, few empirical studies assess the causal impact of financial literacy on individual decision-making. The aim of this paper is exactly to partially fill this gap, by shedding some light on the link between financial literacy and financial behavior, with a focus on the evaluation of financial assets.

A deeper understanding of the relationship between financial literacy and economic behavior is relevant for a multiplicity of reasons. Especially in recent times when the range and variety of financial products and services available to small investors has grown substantially, the level of financial knowledge of an individual is likely to play a major role in determining his choices and consequently, his well-being. Saving and borrowing decisions, mortgages choices, stock market participation and retirement planning are only some of the aspects that can be influenced by agents' degree of financial sophistication.[2] Moreover, the largely documented lack of financial literacy among the adult population gives the room for important policy interventions, whose welfare effects might be extremely relevant.[3]

Still, systematic empirical evidence of the effect of financial literacy on economic behavior is scarce in the literature. The main challenge in this context is the potential endogeneity of financial literacy to the financial behavior of individuals. For instance, it is hard to disentangle whether financial market participation is the result of a higher level of financial sophistication or, *vice versa*, whether people who invest more in financial markets end up being more financially literate. The main contribution of this paper is exactly to tackle this endogeneity concern by designing a laboratory experiment where participants are randomly exposed to a double randomized treatment, thus being split into four groups. All respondents have to evaluate a risky lottery in a setup *à la* Holt and Laury (2002) where the risky option is presented either as a simple coin flip or as a financial security, thus being framed with financial concepts. In the next step, an exogenous increase in participants' level of financial literacy is induced by *teaching* basic financial notions to half of the participants in both groups. Our design allows us to infer the impact of both the *financial framing* and financial literacy on individuals' choices

[2]In this paper we use financial literacy and financial sophistication interchangeably.

[3]Evidence on households' illiteracy was firstly provided by Bernheim (1995, 1998) with US data. More recently Hilgert et al. (2003) and Atkinson and Messy (2012) present analogous findings with data from the Surveys of Consumers and from the OECD INFE Pilot Study, respectively.

by comparing the responses in the four groups.

The main results from the experiment are the followings: i) the financial framing of the lottery makes it less desirable than an equivalent coin toss to individuals not exposed to the *teaching*; ii) the *teaching* - *i.e.*, increasing financial literacy - has an impact on the value assigned to the lottery when financially framed. Consistently with the hypothesis that these effects emerge because of the limited capacity of agents to digest financial concepts, we find that the financial framing significantly reduces the understanding of the lottery's fundamentals. In particular, respondents report a lower understanding of the risky option when financially framed and are also less able to correctly compute its maximum and expected win. However, this distortion is significantly reduced when the *teaching* is provided. This evidence documents that lacking financial knowledge leads to a systematic undervaluation of financial products that would otherwise be desirable to investors. Endowing individuals with more financial literacy might reduce this distortion by enhancing the understanding of financial assets, thus increasing the value agents assign to them.

This paper mainly contributes to the empirical literature focusing on the relationship between financial literacy - or its lack - and economic behavior. An exhaustive summary of this vast body of literature is provided by Lusardi and Mitchell (2014) who carefully review most of the relevant studies in this field. Financial literacy is found to be closely linked to several economic outcomes. It tends to be highly correlated with the activity in financial markets (Christelis et al. (2010); van Rooij et al. (2011a))[4] as well as with the likelihood of undertaking retirement planning (Lusardi and Mitchell (2007a,b, 2011a)) and the ability of households to face negative macro-shocks (Klapper et al. (2013)).[5] Lacking financial knowledge is found to be systematically correlated with many inefficient financial habits: illiterate agents tend to underdiversify their portfolios, and to re-

[4]Similar evidence is also provided by Kimball and Shumway (2006) and Arrondel et al. (2015). Also, Almenberg and Dreber (2015) show that women's lack of financial literacy might explain the gender gap in stock market participation. Relatedly, Cole et al. (2014) finds a causal effect of education, in general, on stock market participation.

[5]Analogous evidence is provided by Lusardi and Mitchell (2011b), Bucher-Koenen and Lusardi (2011), van Rooij et al. (2011b), Klapper and Panos (2011), Fornero and Monticone (2011), Almenberg and Säve-Söderbergh (2011) and Sekita (2011), with data from US, Germany, Netherlands, Russia, Italy, Sweden and Japan, respectively.

balance it less frequently;[6] they pay higher mortgage costs (Moore (2003)), fees and transaction costs and are more likely to use high-cost methods of borrowing (Lusardi and de Bassa Scheresberg (2013); Lusardi and Tufano (2015)).[7]

Despite the abundance of empirical studies, few of them provide causal evidence of the effects of financial literacy, mainly because of two identification threats: omitted variable bias, and reverse causality. Both financial literacy and financial behavior are likely to be jointly affected by other variables that are not always observable - as for instance education or social class status - and whose omission can bias the estimated coefficients.[8] Additionally, financial literacy might be determined itself by financial behavior, since frequent activity in financial markets might lead to higher levels of financial sophistication. Starting from Christiansen et al. (2008), who used as an instrument for financial education new university openings, several authors address such endogeneity issue by applying instrumental variables techniques.[9] Still, this literature suffers from the lack of appropriate instruments.

Alternative approaches to IV estimations - mostly field and natural experiments - produced mixed evidence.[10] Some authors document that enhancing financial literacy can impact on saving and borrowing decisions (Sayinzoga et al. (2016); Haliassos et al. (2017)), boost retirement planning (Song (2015); Duflo and Saez (2003)), improve financial behavior (Drexler et al. (2014)) and lead to higher accumulation of wealth (Bernheim et al. (2001)). Conversely, other studies find no significant differences in the treated and control groups in terms of financial behavior.[11] Given these mixed results, additional causal evidence - possibly coming from randomized controlled trials - is needed to assess the impact

[6]See Gaudecker (2015), Guiso and Jappelli (2009), Calvet et al. (2007) and Calvet et al. (2009).

[7]Campbell (2006) also documents that less-educated households tend to make financial mistakes more often than their more educated counterparts. Relatedly, Brown et al. (2016) provide evidence that financial education improves debt behavior of young Americans.

[8]Theoretical foundations for the endogeneity of financial literacy comes from Jappelli and Padula (2013) and Lusardi et al. (2017). See also Lusardi and Mitchell (2014) for an exhaustive review of the theoretical literature.

[9]See for instance: Lusardi and Mitchell (2010), Sekita (2011), Bucher-Koenen and Lusardi (2011) and Klapper et al. (2013)).

[10]See Hastings et al. (2013) for a review of the related literature.

[11]See for instance Gartner and Todd (2005) Servon and Kaestner (2008) Collins (2013) and Choi et al. (2011).

of financial literacy on financial behavior.[12] This paper follows this direction, by providing causal evidence of the effect of financial literacy on financial behavior in a sample of relatively educated young adults in Spain. The experimental results have large policy implications. We show that even a simple *teaching* of basic notions about securities and returns can be strongly effective in altering individuals' evaluation of financial assets.[13] Also, our findings possibly contribute to explaining the puzzle of low stock market participation: relatively illiterate individuals might tend to avoid financial assets not because of their aversion to risk, but mostly because of their inability to understand assets' fundamentals. This result is in line with recent evidence from Fort et al. (2016), that shows how banks' information policies can effectively increase financial literacy and, in turn, the amount of financial assets held by investors.

Different mechanisms can explain our findings. A possible explanation relies on the concept of ambiguity aversion. Illiterate agents face more ambiguity when making their choices in financial markets and therefore, as long as they are averse to ambiguity, they discount the value of financial assets. So, the role of financial literacy might be to reduce the ambiguity faced at the time of the investment choice, thus making financial products more appealing.[14] We formalize this intuition by presenting a simple model of financial literacy, ambiguity aversion and asset evaluation that provides predictions that are consistent with the experimental results.

The rest of the paper is organized as follows. Section 3.2 details the design of the experiment. A description of the sample and evidence on the validity of the randomization are provided in Section 3.3. Section 3.4 discusses the results. A simple model of asset evaluation with ambiguity averse investors is provided in Section 3.5, together with some additional evidence from the experiment. Finally, Section 3.6 concludes.

[12] This is the conclusion stated by both Lusardi and Mitchell (2014) and Hastings et al. (2013).

[13] We are not the first to document that even short training can be effective in enhancing financial literacy. For instance, both Brugiavini et al. (2015) and Lührmann et al. (2015) report that short-term courses can significantly improve young adults' understanding of financial concepts.

[14] In this sense, our paper is closely related to Dimmock et al. (2016), who show how ambiguity aversion can explain low stock market participation and the tendency of US investors not to own stocks. The authors also show that the negative effect of ambiguity aversion is stronger for illiterate agents, coherently with our findings.

3.2. Experimental Design and Empirical Specification

Measuring the effect of financial literacy on individual behavior in financial markets is empirically challenging. For instance, agents that participate more in financial markets - because of their individual preferences - might end up being more financially literate than agents less prone to do so. At the same time, individuals endowed with a greater stock of financial knowledge might be more inclined to purchase financial products than relatively illiterate agents.

We tackle this endogeneity concern by designing a randomized laboratory experiment in which we ask participants to value a risky option that can be framed either as a *simple* lottery (a coin toss) or as a *financial* lottery (a risky security). In both cases the lottery is exactly the same: a binary lottery that yields either 14 euros or nothing with equal probabilities. However, while the framing of the *simple* lottery does not involve any financial concept, a full understanding of the *financial* one requires some very basic notions about financial markets. To estimate the value that each participant assigns to the risky option - either the coin flip or the financial asset - we follow the setup by Holt and Laury (2002), asking participants to make 20 sequential choices between the risky lottery and a safe amount of money that goes from 50 cents to 10 euros. Within this framework, we can identify the certainty equivalent of the risky option for each participant as the safe amount for which he stops accepting the lottery and switches to the safe amount.

To measure the impact of financial literacy on agents' behavior we introduce an additional source of variation by providing an exogenous increase in participants' level of financial literacy by *teaching* them some financial concepts during the experiment. Our *teaching* treatment consists of a page explaining what a security is, how to calculate returns and what happens in case of default of the issuer.[15] Participants - both facing the *simple* and the *financial* lottery - who are randomly assigned to the *teaching* treatment receives it immediately before making their choices. These two treatment dimensions - *i.e.*, the framing and the *teaching* -

[15] See Appendix 3.A.4 for details about the information provided with the *teaching*.

Figure 3.1: Experimental Design

		Financial framing	
		0	1
Teaching treatment	0	**S**	**F**
	1	**ST**	**FT**

define four different groups: participants in group S face the simple coin toss and receive no *teaching*; participants in group F face the financial lottery and do not receive *teaching*; group ST is exposed to the simple lottery and receive the *teaching*; finally, respondents in group FT are treated with both the financial framing and the *teaching*. The text of the lotteries offered to the participants in each of the four groups is presented in Appendix 3.A.3.

Under this experimental design we can test whether the financial framing shifts individual certainty equivalents - and in what direction - by comparing the average switching point of participants in groups S and F. Furthermore, we can evaluate the role of financial literacy in this context by comparing agents' certainty equivalents in groups F and FT, since participants in this latter group benefit from an exogenous increase in their stock of financial knowledge. Moreover, we can test that any result is not driven by the provision of the *teaching* treatment per se, but rather by an effective increase in the understanding of the *financial* lottery in two ways. Firstly, we can compare the average evaluation of the lottery in groups S and ST. As long as the *teaching* is actually increasing financial literacy without altering the behavior of participants - for instance, providing incentives to concentrate more - no differences should emerge in the subsample of participants evaluating the coin flip. Additionally, we check whether the teaching actually increases the understanding of the risky lottery when financially framed. To measure both their perceived and objective understanding, we ask participants to report how much they think they understood about the fundamentals of the lottery (in a scale from 0 to 10) and to indicate both the maximum and the expected win from the lottery. Additionally, we also ask which of the notions provided with the *teaching* they find most useful.

To assess the *ex-ante* degree of financial sophistication of participants, we also present them a set of ten financial literacy questions that we include in the survey preceding the lottery choice.[16] These are standard questions widely used to measure financial knowledge and include the usual questions about inflation, interest compounding and diversification. In addition to those, we use some more advanced questions about bond, stocks and options and two other questions requiring some numerical computations.[17] Our financial literacy measure equals the number of correct answers to the survey, thus ranging from 0 to 10. We use this information to measure the correlation between *ex-ante* financial literacy and individual certainty equivalents and to check whether our sample reproduces the common financial literacy patterns found in the literature.

Finally, at the end of the experiment we ask participants to evaluate an ambiguous lottery. To do so, we ask participants to make twenty sequential choices between drawing a ball from a box containing green and blue balls in unknown proportion and a safe amount of money. When choosing the ball, participants can win either 5 euros - if the ball is green - or 0, otherwise. The safe amount offered ranges from 0.25 euros to 5 euros, and the certainty equivalent of this lottery is defined as the safe amount at which agents switch from choosing the urn to choosing the safe amount.[18] From the certainty equivalent, we construct a proxy for individuals' attitudes towards ambiguity, that goes from 0 in case an agent always chooses to draw the ball to 10 if he never does so.

Given the design of the experiment, we infer the causal impact of financial literacy on asset evaluation by estimating the following specification:

$$CE_i = \alpha + \gamma TEACH_i + \delta FINLOT_i + \beta TEACH_i \times FINLOT_i + \phi X_i + \varepsilon_i, \tag{3.1}$$

where CE_i is the certainty equivalent of the risky lottery for individual i. $TEACH$ is a dummy variable that equals 1 when the individual receives the *teaching* - *i.e.*, the exogenous increase in its level of financial literacy - and $FINLOT$ is a

[16]This survey also includes other general questions, through which we collect personal information about age, income, education, etc. See Appendix 3.A.1 for a complete list of these questions.

[17]See Appendix 3.A.2 for the detailed list of the financial literacy questions used in the survey.

[18]The ambiguous lottery offered to respondents is detailed at the end of Appendix 3.A.3.

dummy that is equal to 1 when the agent faces the financially framed lottery (and 0 if he faces the coin flip). Finally, X is a vector of individual controls, including age, sex, education and *pre*-treatment level of financial literacy that we include to gain precision. According to this specification, δ measures the effect of facing a financially framed lottery compared to a *simple* coin-flip lottery. γ measures the impact of the *teaching* on agents facing the *simple* lottery, and β captures the effect of an increase in financial literacy on the value assigned to the financial asset by agents facing the *financial* lottery.

A priori, two main competing hypothesis on the effect of financial literacy on the propensity of respondents to undertake the risky option can be tested with this specification by looking at the sign of the estimated coefficients. Either agents lacking financial literacy might be more averse to undertake the risky lottery when financially framed (negative δ), and an exogenous increase in financial literacy might reduce this distortion, by increasing the individual certainty equivalent (positive β). Or, less financially sophisticated agents might tend to overestimate their level of financial literacy and the value of financial assets (positive δ) and again, financial literacy might reduce this distortion by lowering the certainty equivalent (β negative). In both cases, and crucially to our identification, we expect γ to be statistically not different from zero: as long as the *teaching* affects participants' behavior only through an increase in financial literacy, the *teaching* should only be effective in the subsample of agents evaluating the financially framed lottery.

Once estimated the effect of the *teaching* on the individual valuation of the lottery, we test whether this effect is actually due to an increase in the understanding of the *financial* lottery. Hence, to estimate whether our *teaching* actually helps individuals to recognize the fundamentals of the lottery - when financially framed - we estimate:

$$UND_i = \alpha + \gamma TEACH_i + \delta FINLOT_i + \beta TEACH_i \times FINLOT_i + \phi X_i + \varepsilon_i, \quad (3.2)$$

where UND_i is either the self-reported understanding of the lottery - how much participant i believes he understood about the fundamentals of the lottery - or the actual understanding of the latter. In this case UND_i is a dummy variable that equals 1 when the participant is able to compute the maximum and the average win achievable when choosing the risky option. According to the hypothesis that the financial framing reduces the understanding of the lottery and that the *teaching* can effectively reduce this distortion by helping respondents to correctly identify the fundamentals of the risky option, we expect β to be significantly positive, δ to be negative and γ to be statistically not different from zero.

3.3. Sample Description

The experiment was run at the Behavioral Sciences Laboratory of the University Pompeu Fabra in Barcelona in December 2016. In total, eleven sessions took place - each of them with around 24 participants - over two days. Our sample consists of 260 participants, randomly divided in four groups. Table 3.1 presents descriptive statistics about the sample of participants. Around 65% of participants are female and the average age in the sample is 21 but we have also participants more than 30 years old. Only 24% of participants took a finance class before participating in the experiment, even though around one third of them studied either economics and finance or political sciences. Self-assessed financial literacy is around 4 - in a scale from 0 to 10 - and the average score in the financial literacy test is 5.5 out of 10. Finally, the fraction of individuals behaving irrationally when evaluating the lottery, that is, choosing more than a single switching point in our setup *à la* Holt and Laury is equal to 25%. Table 3.1 also reports the differences in mean of all of these variables among the different groups. No statistically relevant differences emerge, thus confirming the goodness of the randomization.

As regards the distribution of the financial literacy measure across individuals, Figure 3.2 provides a graphical representation of it. The median score in the financial literacy test is 5. Around 20% of respondents correctly answered to less than 4 questions and only 5% scored 10 out of 10. The share of correct answers is widely heterogeneous across questions. More than 70% of participants answer to the questions about inflation, definition of stocks and diversification. Conversely, less than 30% of participants knew about the relationship between bond prices and interest rates. Also, no more than 40% of respondents were able to compute the expected value of a simple scratch card and the value of a property in two years, knowing the yearly percentage increase in its price.[19]. Around 50% to 60% of correct answers were collected on the remaining questions about interest rates, riskiness of stock vs bonds, call options and bond definition. These results are pretty much comparable with evidence provided in similar surveys. For instance, van Rooij et al. (2011a) also find that only 24.6% of respondents to the 2005-2006 DNB Household Survey correctly answer to the question about interest rate and bond prices (29% in our sample), whilst 63.3% know about diversification (70% in our case); 60.2% recognize that stocks are normally riskier than bonds (56.92% in our survey) and 55.5% know what a bond is (in our case, 58.08%).

The score in the financial literacy test gives us the possibility to test the common patterns in financial literacy observed in the literature. Table 3.2 shows the coefficient of a regression in which our measure of *ex-ante* financial literacy is regressed on some individual characteristics of respondents. The financial literacy score is significantly lower for females, and tends to increase with self-reported income (even thought this effect vanishes when controlling for education). As one would expect, participants with a degree in economics and finance, as well as participants who took a finance course during their careers score higher than the rest of respondents. [20] Similar results emerge when using self-reported financial literacy as the dependent variable. These results are coherent with the usual patterns found by most of the previous studies in the literature.[21]

3.4. Results

The randomized nature of the experiment allows to estimate the main effects of our treatments by simply comparing the average certainty equivalent – *i.e.*, the average safe amount at which agents stop choosing the risky option - in the four groups. Figure 3.3 provides a graphical representation of the main results. Firstly, the financial framing appears to reduce the average value assigned to the risky

[19]These two were the only questions that were not multiple-choice.

[20]The level of education per se has no significant impact on the scoring but this might be due to the relatively small variation in education level in our sample of young relatively-educated respondents.

[21]See Lusardi and Mitchell (2014) for an exhaustive review of these works and a summary of their results.

lottery. Then, and most importantly, participants exposed to the simple coin-toss lottery do not alter their behavior when receiving the *teaching*, whilst the latter effectively enhances the evaluation of the lottery when this is framed as a financial security.

Table 3.3 presents the main results from a systematic analysis of these effects. In particular, the table contains the estimates of equation 3.1 under different specifications. In all of the regressions, the dependent variable is the certainty equivalent of the lottery, evaluated as the safe amount at which an individual starts preferring the safe amount to the risky alternative.[22] Column 1 presents the OLS estimate with no controls nor fixed effect. In columns 2-4 additional controls and session fixed effects are included. Finally, column 5 reports the estimates from a Tobit model that accounts for the upper and lower limit on the safe amount offered to participants, the latter being included between 0 and 10 euros.

By estimating equation 3.1 on the sample of participants, we get the following results. Firstly, framing the risky option as a financial security rather than a simple coin flip reduces its value to participants by around 18% (approximately, 1 euro in a lottery whose expected value is 7 euros). Second, the *teaching* has no effect on the choice made by agents in the *simple* groups. Most importantly, the *teaching* has a positive and significant effect on the choice made by participants facing the *financial* lottery. In particular, receiving the *teaching* increases the value assigned to the financial asset by around 1.3 to 1.5 euros, depending on the specification, thus completely offsetting the negative effect of the financial framing. Importantly, a higher scoring in the financial literacy test is also associated with higher certainty equivalents, whilst the self-evaluation of financial literacy has no - at least significant - effect on the choice. It is worth noticing that Tobit coefficients do not differ from the OLS ones, since most of the participants choose a switching point that is strictly included in the interval made available to them.

Further confirmation to this evidence comes from the regressions in Table 3.4 where we estimate the effect of the *teaching* on the probability of choosing the lottery for each of the 20 safe amounts offered in each row. In this case, we present

[22] As standard in most of the experiments *à la* Holt and Laury, individuals switching more than once are excluded from the analysis because of their irrational behavior. In our case these are around 25% of the initial sample. Importantly, the number of multiple switchers in the four groups is not systematically different, as shown in Table 3.1.

the estimates when including multiple switchers in the regressions (Panel A) and when excluding them (Panel B). As one can notice, the *teaching* was particularly effective on the probability of choosing the risky option when the safe amount ranges between 5.5 and 6.5 euros. This evidence is consistent with the idea that increasing financial literacy impacts on the behavior of the marginal respondent. Nor the very risk-averse or the very risk-lover investor is significantly affected by the provision of financial sophistication. Figure 3.4 illustrates this finding by plotting the share of respondents that opts for the risky alternative for each of the twenty safe amounts.

To dig deeper in the mechanism leading to these main results, we also estimate how the random assignment to the groups affect the understanding of the lottery. To this goal, we use both a measure of self-reported evaluation and three different objective measures: i) $Correct_1$ is a dummy that equals 1 when the participant correctly identifies the maximum win achievable when choosing the lottery (14 euros); ii) $Correct_2$ is a dummy that equals 1 when the participant correctly infer the average win from the lottery (7 euros); $Correct$ is a dummy that equals 1 when both questions are correctly answered.

Table 3.5 presents the results from estimating equation 3.2. Consistently with the hypothesis that agents have difficulties in understanding the characteristics of the lottery when financially framed, we find that the coefficient of $FINLOT$ is negative and largely significant. The financial framing indeed reduces the self-reported understanding of the lottery by more than 2 points (in a scale from 0 to 10) and reduces by around 50% the probability agents can correctly recognize either the expected win or the maximum win from the risky lottery. The *teaching* significantly increases both the self-reported and the objective understanding of the lottery when financially framed (the coefficient of $FINLOT \times TEACH$ is significantly positive in all columns, except column 3, when it remains however positive). Finally, the *teaching* given to agents facing the *simple* lottery does not significantly affect their understanding of the *simple* lottery, consistently with the idea that financial literacy only affects participants' behavior when making choices that involve financial notions.

Additional evidence on the importance of the *teaching* for agents evaluating the security comes from Figure 3.5 where we plot the distribution of the "usefulness" of the *teaching* for agents facing the *simple* and the *financial* lottery, respectively. As expected, the majority of respondents evaluating the *financial* lottery found the *teaching* particularly useful when making their choice, whilst very few respondents evaluating the coin toss assigned to it a value higher than 5. Further confirmation of these results come from the answers to the question about which of the information provided in the *teaching* respondents find more useful. Most of the respondents that received the *teaching* in the simple group found none of the information provided of some use. In the financially framed group, not surprisingly, the answer picked by most of the participants was"how to compute returns", thus showing that learning about returns was indeed useful when making the choice about accepting the lottery or not.[23]

When put together, these results delivers a picture that can explain how financial literacy can affect the subjective evaluation of financial assets. Lacking financial literacy reduces the understanding of securities' fundamentals and leads to a systematic undervaluation of financial assets. Increasing financial literacy - thus enhancing the understanding of financial products - can reduce this distortion, by allowing agents to behave according to their true risk preferences.

3.5. Discussion

The experimental evidence described so far documents that: i) financial assets might be under-evaluated by agents, when they are not able to properly identify the fundamentals; ii) increasing financial literacy can effectively reduce this distortion by helping agents recognize the fundamentals and therefore evaluate the lottery as if it was a simple coin flip. A possible explanation for these results relies on the concept of ambiguity aversion. Indeed, lacking financial literacy is likely to increase the ambiguity faced by an investor when making his investment choice, thus lowering his willingness to undertake risk and to invest in financial products. Reasonably, the probability of committing a mistake when evaluating a financial product depends on the level of financial literacy of the investor, and illiterate

[23]Figure 3.6 provides a graphical representation of this result, by showing the difference in the share of participants choosing each of the four possible answers in the *simple* and the *financial* groups.

agents have a higher probability of either overestimating or underestimating the value of the investment. When agents are not naive, they are perfectly aware of this higher probability of committing mistakes and, if ambiguity averse, they are more afraid of overestimating a“bad” product than of underestimating a “good” one. As a result, illiterate agents have lower incentives to invest in financial markets when ambiguity averse. This mechanism would be also consistent with the evidence provided by Dimmock et al. (2016), who document the correlation between ambiguity aversion and stock market participation.

To formally model the aforementioned mechanism linking financial literacy, ambiguity aversion and financial assets' evaluation, we develop a simple model of asset evaluation in the presence of ambiguity aversion in agents with heterogenous levels of financial literacy.

3.5.1. A Model of Financial Literacy, Ambiguity Aversion and Asset Evaluation

Consider a risk-averse and Decision Maker (DM) that has to evaluate a risky asset yielding either x_1 or $x_2 < x_1$, with probabilities p and $1 - p$, respectively. The DM is endowed with a given level of financial literacy, θ, and does not observe the probability of the best outcome, namely p, but only a noisy signal $\hat{p}$, whose precision depends on her level of financial literacy. In particular, with probability $\pi(\theta)$ the signal the DM receives is correct and $\hat{p} = p$, whilst, with the complementary probability, the signal the DM observes is distorted. In this case, the observed probability can be either larger or smaller, by ε, than the true p and the two cases are equally likely to occur. The DM knows both her level of financial literacy and the consequent probability of observing a precise signal ($\pi'(\theta) > 0$). Therefore, she knows that the distribution of p conditional on receiving a signal $\hat{p}$ is:

$$p = \begin{cases} \hat{p} + \varepsilon, & \text{with prob. } (1 - \pi(\theta))/2; \\ \hat{p}, & \text{with prob. } \pi(\theta); \\ \hat{p} - \varepsilon, & \text{with prob. } (1 - \pi(\theta))/2. \end{cases}$$

To model ambiguity aversion, we assume that the DM assigns different weights to the possible scenarios, that is, to the three possible probability distributions over the lottery.[24] The weights - that is, the subjective measures assigned to the possibility of underestimating or overestimating the likelihood of the best outcome - are function of both the objective probability of each state of nature and ambiguity aversion, the latter being captured by a parameter α. Hence, the set of subjective measures assigned to the three states of natures are:

$$\begin{aligned} \omega(p < \hat{p}) &= \alpha(1-\pi) \\ \omega(p = \hat{p}) &= \pi \\ \omega(p > \hat{p}) &= (1-\alpha)(1-\pi). \end{aligned}$$

The DM is ambiguity averse as long as α is greater than $\frac{1}{2}$. In this case she assigns a subjective weight to the probability of being overestimating the probability of the good outcome that is higher than the one she assigns to the other extreme case.[25] Hence, the utility the DM gets from the asset can be written as:

$$\begin{aligned} \alpha EU(A) = & \underbrace{\alpha(1-\pi)}_{\omega(p<\hat{p})}\underbrace{[(\hat{p}-\varepsilon)U(x_1)+(1-\hat{p}+\varepsilon)U(x_2)]}_{EU(A)^-}+ \\ & + \underbrace{\pi}_{\omega(p=\hat{p})}\underbrace{[\hat{p}U(x_1)+(1-\hat{p})U(x_2)]}_{\overline{EU(A)}}+ \\ & + \underbrace{(1-\alpha)(1-\pi)}_{\omega(p>\hat{p})}\underbrace{[(\hat{p}+\varepsilon)U(x_1)+(1-\hat{p}-\varepsilon)U(x_2)]}_{EU(A)^+}. \end{aligned} \tag{3.3}$$

where $\overline{EU(A)}$; is the expected utility from the asset conditional on having received a precise signal about p. $EU(A)^-$ is the expected utility the DM obtains conditional on having overestimated the likelihood of the best outcome and $EU(A)^+$ is the expected utility the agent gets in case the opposite occurs and $p > \hat{p}$.

[24]Our framework is related to the one by Ghirardato et al. (2004) but allowing individuals to weight also intermediate states of nature. In this sense, this work is also related to Klibanoff et al. (2005).

[25]Notice that, when $\alpha = \frac{1}{2}$, the DM is ambiguity-neutral and the weights will simply be the objective probabilities associated to the different states of nature. In this case the Expected Utility from the asset would simply be $EU(A) = \hat{p}U(x_1) + (1-\hat{p})U(x_2)$, and does not depend on the precision of the signal, nor on financial literacy.

Equation 3.3 simplifies to:

$$\begin{aligned}\alpha EU(A) = \pi\left[\hat{p}U(x_1) + (1-\hat{p})U(x_2)\right] + \\ + (1-\pi)[(\hat{p} - \varepsilon(2\alpha-1))U(x_1) + \\ + (1-\hat{p} + \varepsilon(2\alpha-1))U(x_2)]\end{aligned}$$

and the utility that the DM gets from the asset is increasing in the precision of the signal as long as the DM is ambiguity averse, since:

$$\frac{\partial \alpha MEU(A)}{\partial \pi} = \varepsilon(2\alpha-1)(U(x_1) - U(x_2)) > 0 \Leftrightarrow \alpha > \frac{1}{2}.$$

.

Being signal's precision an increasing function of financial literacy - *i.e.*, $\pi'(\theta) > 0$ - the latter also increases the utility the an ambiguity averse DM gets from the asset.

$$\frac{\partial \alpha EU(A)}{\partial \theta} = \frac{\partial \alpha MEU(A)}{\partial \pi(\theta)}\pi'(\theta) > 0.$$

When asked to exchange the asset with a certain amount of money, an ambiguity averse DM will require at least an amount that gives her the same utility she gets from taking the lottery. This minimum amount - that we define as αCE - is therefore the certainty equivalent of the asset evaluated using our αEU utility function. In particular, αCE is given by:

$$\begin{aligned}\alpha CE(A) = U^{-1}\{\pi\left[\hat{p}U(x_1) + (1-\hat{p})U(x_2)\right] + \\ + (1-\pi)[(\hat{p} - \varepsilon(2\alpha-1))U(x_1) + \\ + (1-\hat{p} + \varepsilon(2\alpha-1))U(x_2)\},\end{aligned} \tag{3.4}$$

and is therefore increasing in both π and θ.

To conclude, financial literacy increases the value that an ambiguity averse decision maker assigns to a risky asset. This happens because financial literacy enhances her ability to correctly identify the fundamentals of the asset, thus reducing the ambiguity she faces during the valuation process.

3.5.2. Additional Evidence from the Laboratory

To provide evidence consistent with the prediction of the model, we exploit some additional results from the experiment. Mainly, we test the following hypothesis: i) agents that are more ambiguity averse are the ones that are most negatively affected by the framing of the lottery; ii) agents' evaluation of the financial asset increases in the understanding of the fundamentals. To do so, we exploit some heterogeneity in our results. Firstly, we estimate the effect of the financial framing on the subset of agents that do not receive the *teaching*, controlling for their level of ambiguity aversion. Then, we exploit the heterogeneity in the understanding of the lottery in the subsample of agents that evaluate the *financial* one. We test whether participants that report a higher understanding actually assign a larger value to the security.[26]

Table 3.6 presents the evidence from this additional set of analysis. In all columns the dependent variable is the logarithm of the certainty equivalent, so that the estimated coefficients can be interpreted as the percentage change in the value of the asset after changes in the independent variables.[27] Estimates in columns 1 and 2 show that, among participants that do not receive the *teaching*: i) the financial framing reduces the certainty equivalent of the lottery by around 26% to 40% to agents; ii) respondents in the top 25% of the distribution of the proxy for ambiguity aversion tend to discount the lottery by around 75% to 95% of its value in the *simple* lottery; iii) in the *financial* lottery group, the effect of the framing is amplified by ambiguity aversion (the coefficient of the interaction term is negative, even if not significant). The estimates in columns 3 and 4 also document that an increase in 1 point in the measure of self-reported understanding is associated with an increase of around 10% in the certainty equivalent of the financial lottery. Hence, understanding the lottery makes it more valuable to participants.

[26] In this case we control for receiving the *teaching* since this affects both the understanding and the certainty equivalent.

[27] We prefer the log instead of the level in this set of regressions since the average certainty equivalent among the top ambiguity averse and the rest of participants is not comparable and estimates would be harder to interpret.

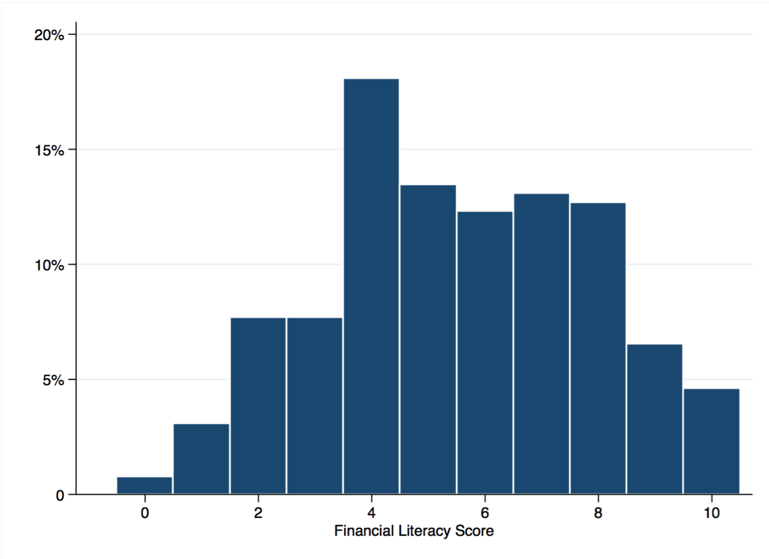
3.6. Conclusions

Financial literacy potentially affects financial behavior in many ways. Providing causal evidence of these effects is challenging, since financial literacy is likely to be endogenous to several individual characteristics that are also likely to determine financial behavior. In this paper, we exploit a randomized laboratory experiment to test whether an exogenous increase in financial literacy, provided through a simple *teaching* of few basic financial notions actually affects the value agents assign to financial assets.

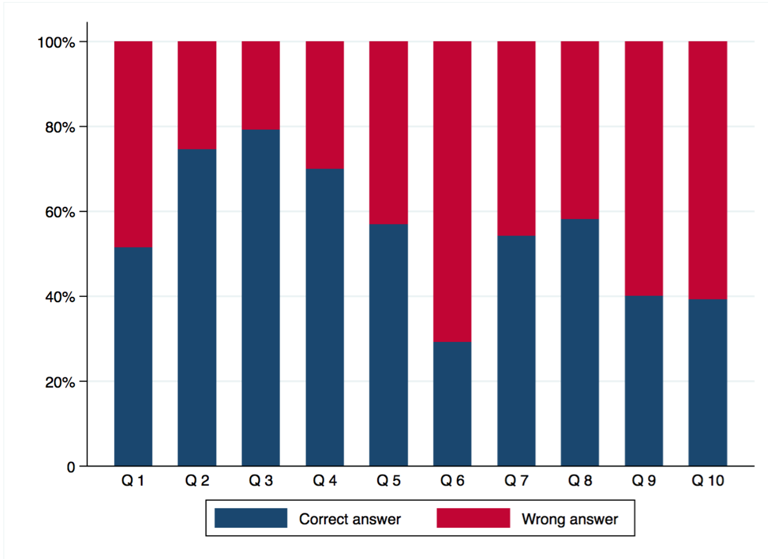
Our findings confirm that financial literacy significantly affects the valuation of financial assets: agents exposed to the *teaching* assign a value to the risky option that is much higher than their illiterate counterparts. Also, they report a higher understanding of the fundamentals of the lottery, which can explain the result. To dig deeper into the channel that relates financial literacy, the understanding and the value assigned to the lottery, we develop a model of asset valuation with ambiguity averse agents with heterogeneous financial literacy. The predictions from the model are consistent with the experimental evidence.

These results have relevant policy implications. According to our findings, financial illiteracy might lead to systematic undervaluation of financial securities, thus partially explaining the puzzle of low stock market participation. Moreover, even short trainings teaching basic notions about financial markets and products can be effective in reducing this distortion. Further research might follow the approach proposed in this paper by designing alternative experiments where agents are exposed to the same type of randomization so as to evaluate both the impact of the financial framing and financial literacy on the financial behavior. Possibly, designing a field experiment with these characteristics would be ideal to provide evidence with the highest possible degree of external validity.

Figure 3.2: Distribution of Financial Literacy



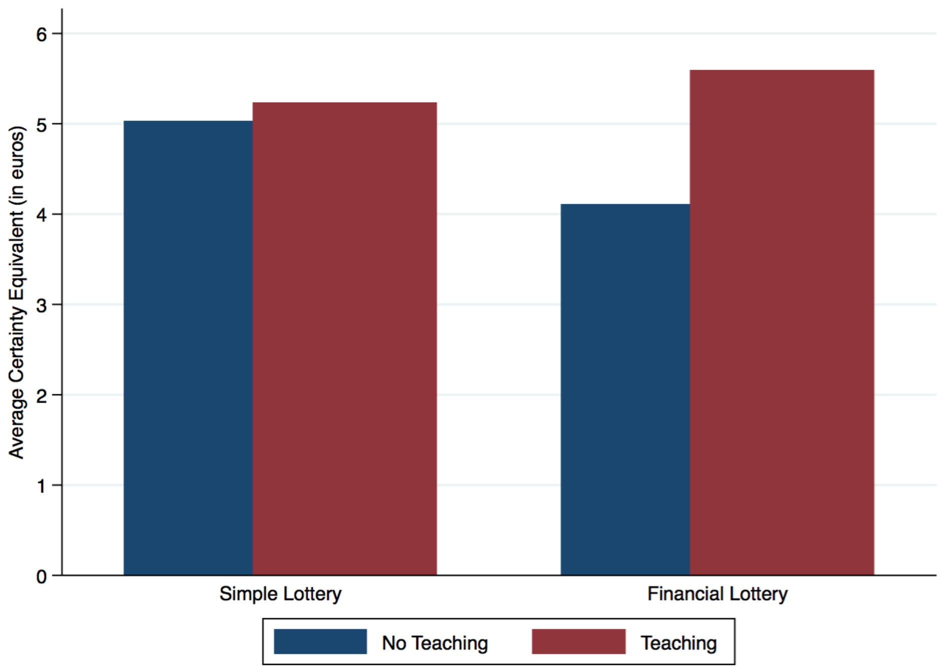
Aggregate



By question

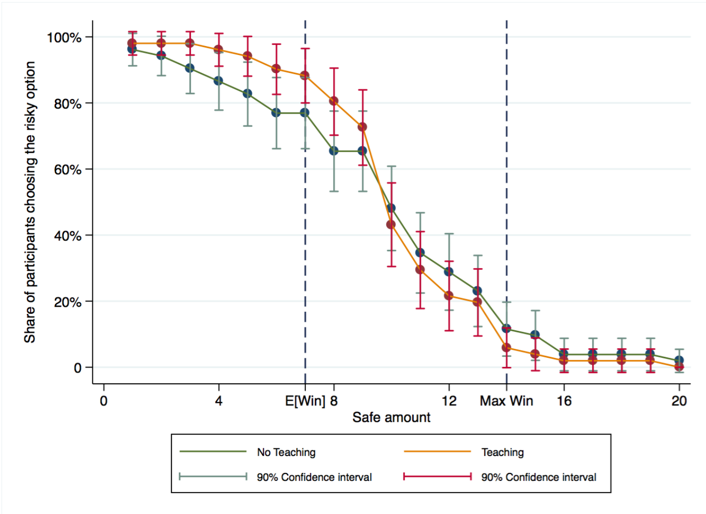
Note: The left panel of this figure plots the distribution in the score obtained in the financial literacy test. The score equals the number of questions correctly answered. The right panel details the share of correct and wrong answers to each of the 10 questions in the test.

Figure 3.3: Certainty equivalent by groups

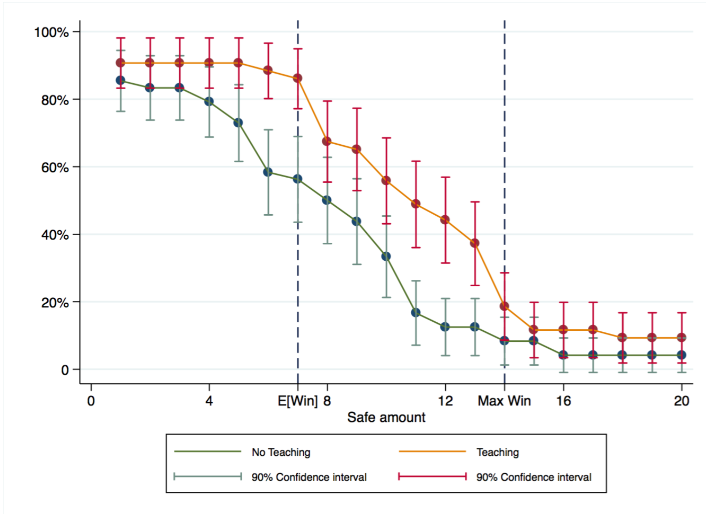


Note: This figure plots the average certainty equivalent (in euros) of the risky lottery in each of the four groups. The certainty equivalent corresponds to the safe amount for which respondents stop choosing the risky option and prefer the safe alternative.

Figure 3.4: Financial Literacy and the probability of choosing the risky amount



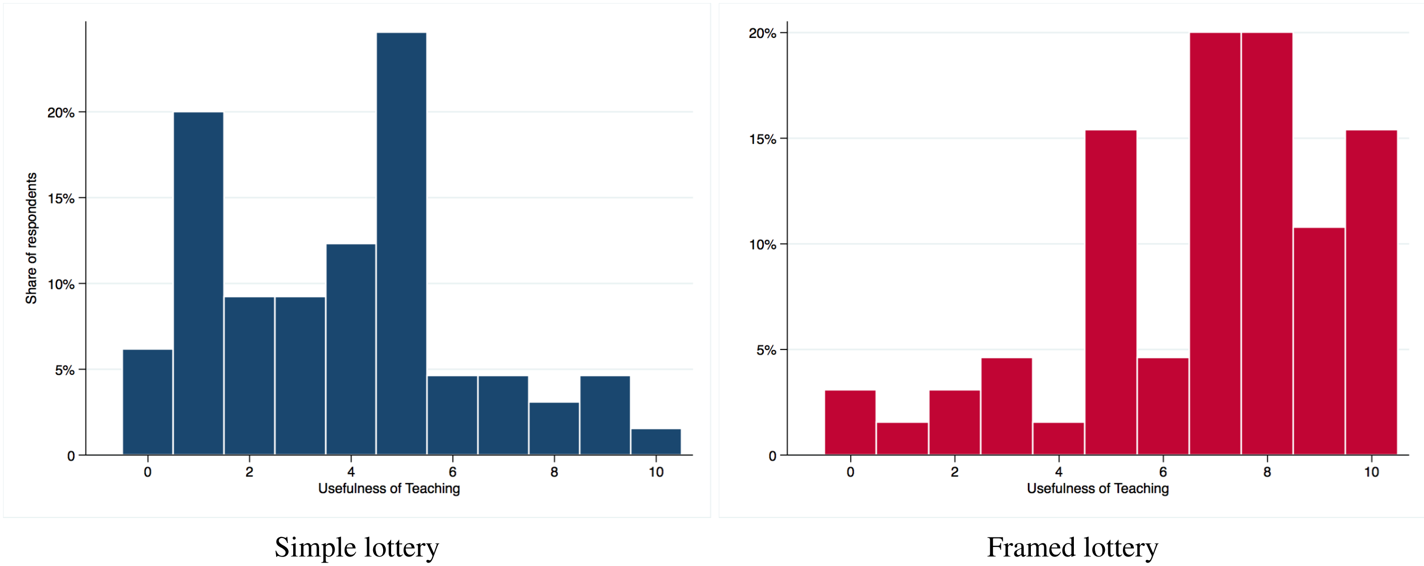
Simple lottery



Framed lottery

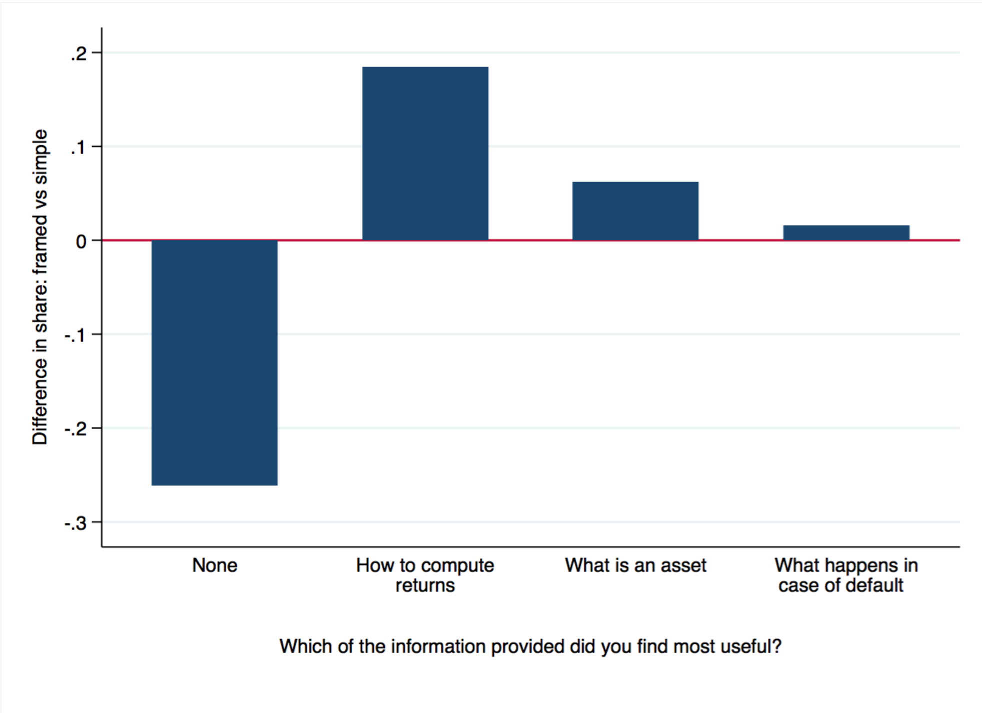
Note: This figure plots the distribution in the probability of choosing the risky lottery, for the different values of the safe amount. The left panel plots the share of respondents opting for the risky choice for different values of the safe amount - on the horizontal axis - with and without the *teaching* in the group evaluating the lottery when framed as a coin flip. The right panel reports the same distribution for individuals evaluating the lottery when financially framed.

Figure 3.5: Usefulness of teaching, by groups



Note: This figure plots the distribution in the value assigned to the usefulness of the *teaching* by participants that received it during the experiment. The value is in a scale from 0 to 10. The left panel plots the share of respondents that indicated each of the possible 10 values as a measure of how useful the *teaching* was in the group evaluating the lottery when framed as a coin toss. The right panel reports the same distribution for individuals evaluating the lottery when financially framed.

Figure 3.6: Usefulness of different information provided, comparison framed/simple group



Note: This figure plots the difference in the share of respondents indicating each of the four possible answer to the question *"Which of the information provided did you find most useful when making your choices?"* for individuals evaluating the *financial* and the *simple* lottery, respectively. Negative values correspond the a larger share of respondents picking that option in the *simple* group, whilst positive values result from a larger share of participants choosing that answer in the *financial* group.

Table 3.1: Summary Statistics

Participants Characteristics and Mean Differences between Groups	Mean	St. Dev.	$\mu_F - \mu_S$	$\mu_{ST} - \mu_S$	$\mu_{FT} - \mu_S$
Female	0.65	0.48	-0.06	-0.03	0.05
Age	21.14	3.29	0.35	-0.77	-0.02
Work	0.32	0.47	-0.05	-0.06	-0.02
Working years	1.48	2.47	-0.02	-0.32	-0.29
Self-reported Income $>$ 80K euros	0.05	0.23	0.00	0.02	-0.02
Self-reported Income 40K-80K euros	0.27	0.45	-0.03	0.00	0.14
Self-reported Income $<$ 40K euros	0.54	0.50	0.05	0.00	-0.11
Education level: High School Diploma	0.12	0.32	-0.02	0.09	0.03
Education level: Bachelor's Degree	0.74	0.44	0.02	-0.06	-0.06
Education level: Master	0.10	0.31	0.00	-0.03	0.02
Education level: PhD	0.02	0.15	0.02	-0.02	0.00
Field of studies: Economics/Finance/Pol. Sciences	0.35	0.48	0.00	-0.03	0.06
Field of studies: Humanities/Law	0.29	0.45	0.02	0.02	-0.02
Field of studies: Medicine/Biology/Psichology	0.12	0.33	0.00	-0.05	0.02
Field of studies: Other	0.24	0.43	-0.02	0.06	-0.06
Took a finance course	0.24	0.43	0.03	-0.03	0.05
Self-assessed Financial Literacy (0-10)	4.24	1.81	0.05	-0.54	-0.25
Financial Literacy (0-10)	5.53	2.37	0.03	-0.08	-0.14
Multiple Switchers	0.25	0.44	0.06	-0.02	0.14
C.E. Ambiguous Lottery	2.68	1.06	0.12	0.17	0.10

Note: This table reports the summary statistics about the characteristics of the participants, as well as the difference between the mean in group S (simple lottery with no teaching) and the mean in each of the three other groups. *, ** and *** indicate that the mean difference is statistically different from 0 at the 99, 95 and 90% confidence level, respectively. *Financial Literacy* and *Self-assessed Financial Literacy* are on a scale from 0 to 10. The Certainty Equivalent of the ambiguous lottery goes from 0 to 5. Except for Age and Working years all of the other variables are indicator variables.

Table 3.2: Financial Literacy regressions

Dependent Variable: Financial Literacy (either measured or selfevaluated)				
	(1)	(2)	(3)	(4)
	Fin. Lit.	Fin. Lit.	Fin. Lit.	Self-ass. FL
Female	-1.189***	-1.150***	-0.899***	-0.578***
	(0.300)	(0.302)	(0.241)	(0.218)
Age	0.027	0.057	0.087	-0.074
	(0.043)	(0.068)	(0.062)	(0.056)
Work		-0.312	-0.244	-0.228
		(0.337)	(0.273)	(0.248)
Working years		-0.017	0.026	0.142**
		(0.092)	(0.077)	(0.069)
Self-reported Income $>$ 80K euros		0.615	0.497	1.082**
		(0.643)	(0.512)	(0.461)
Education level: Bachelor's Degree			0.492	0.453
			(0.351)	(0.317)
Education level: Master			0.645	0.856*
			(0.526)	(0.474)
Education level: PhD			0.274	0.454
			(0.914)	(0.823)
Field of studies: Econ./Finance/Pol. Sciences			2.735***	0.604**
			(0.321)	(0.289)
Field of studies: Humanities/Law			0.539*	-0.047
			(0.318)	(0.289)
Field of studies: Medicine/Biology/Psichology			0.613	-0.286
			(0.412)	(0.371)
Took a finance course			1.211***	1.062***
			(0.294)	(0.265)
Constant	5.733***	5.159***	2.385*	5.126***
	(0.957)	(1.366)	(1.240)	(1.117)
Mean Dep. Var.	5.531	5.531	5.531	5.547
Standard dev.	2.365	2.365	2.365	2.364
Observations	260	260	260	258
R^2	0.060	0.067	0.436	0.217

Note: The Table reports the OLS coefficients of individual characteristics on the number of correct answers in the financial literacy survey. The dependent variable in columns (1) to (3) is the score of correct answers in the financial literacy survey. The dependent variable in column (4) is self-assessed financial literacy. Both are on a scale from 0 to 10. Except for Age and Working years all of the variables are indicator variables. Standard errors in parenthesis. *** $p < 0.01$, ** $p < 0.05$, *$p < 0.10$.

Table 3.3: Financial Literacy and Asset Evaluation

Dependent Variable: Certainty Equivalent of the Risky Lottery					
	(1)	(2)	(3)	(4)	(5)
	OLS	OLS	OLS	OLS	Tobit
FINLOT	-0.925**	-1.096**	-1.062**	-1.088**	-1.091**
	(0.435)	(0.449)	(0.440)	(0.446)	(0.423)
TEACH	0.206	0.156	0.161	-0.021	0.143
	(0.429)	(0.440)	(0.431)	(0.446)	(0.415)
FINLOT$\times TEACH$	1.282**	1.405**	1.398**	1.566**	1.458**
	(0.626)	(0.652)	(0.639)	(0.651)	(0.615)
Financial Literacy (0-10)			0.259***		
			(0.095)		
Self-assessed Financial Literacy (0-10)				0.117	
				(0.102)	
Session FE	No	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes	Yes
Observations	194	194	194	192	194
R-squared	0.059	0.266	0.299	0.272	

Note: The Table reports the estimates of equation 3.1. The dependent variable in all of the regressions is the certainty equivalent of the risky lottery, measured as the safe amount at which an individual stops accepting the lottery. $TEACH$ and $FINLOT$ are dummy variables that equal 1 when the individual receives the *teaching* and faces the financially framed lottery, respectively. The Controls in columns (2) to (5) include Female, Age, Work, Education dummies, Income dummies and Field-of-Study dummies. Financial Literacy equals the score of correct answers in the financial literacy survey. Estimates in columns (1) to (4) are obtained by OLS. In column (5) a Tobit model censored at 0 and 10 is assumed. Session FE are dummies accounting for the different experimental rounds. Standard errors in parenthesis. *** $p< 0.01$, ** $p< 0.05$, *$p< 0.10$.

Table 3.4: Financial Literacy and Asset Evaluation (2)

Dependent Variable: Probability of choosing the risky asset, for different values of the safe amount																				
Panel A: Regressions including multiple switchers																				
	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00
FINLOT	-0.138***	-0.077	-0.185***	-0.138**	-0.062	-0.169**	-0.123	-0.169**	-0.200**	-0.154*	-0.138	-0.138*	-0.062	-0.046	-0.000	0.108*	0.046	0.046	0.062	0.062
	(0.051)	(0.058)	(0.057)	(0.067)	(0.065)	(0.074)	(0.075)	(0.083)	(0.084)	(0.086)	(0.085)	(0.078)	(0.080)	(0.064)	(0.064)	(0.059)	(0.056)	(0.055)	(0.056)	(0.051)
TEACH	0.015	0.046	0.062	0.092	0.108*	0.138*	0.169**	0.123	0.092	-0.123	-0.046	-0.062	0.000	-0.046	-0.031	0.062	-0.031	0.000	0.000	-0.015
	(0.051)	(0.058)	(0.057)	(0.067)	(0.065)	(0.074)	(0.075)	(0.083)	(0.084)	(0.086)	(0.085)	(0.078)	(0.080)	(0.064)	(0.064)	(0.059)	(0.056)	(0.055)	(0.056)	(0.051)
$FIN \times TEACH$	0.046	-0.015	0.092	0.077	-0.015	0.154	0.092	0.092	0.108	0.308**	0.262**	0.354***	0.154	0.215**	0.138	-0.000	0.062	0.108	0.031	0.200***
	(0.072)	(0.082)	(0.081)	(0.095)	(0.092)	(0.104)	(0.106)	(0.118)	(0.118)	(0.122)	(0.120)	(0.111)	(0.114)	(0.090)	(0.090)	(0.083)	(0.079)	(0.077)	(0.079)	(0.072)
Constant	0.954***	0.892***	0.908***	0.815***	0.815***	0.723***	0.692***	0.631***	0.646***	0.492***	0.415***	0.308***	0.292***	0.154***	0.138***	0.046	0.092**	0.062	0.077*	0.031
	(0.036)	(0.041)	(0.041)	(0.048)	(0.046)	(0.052)	(0.053)	(0.059)	(0.059)	(0.061)	(0.060)	(0.055)	(0.057)	(0.045)	(0.045)	(0.041)	(0.040)	(0.039)	(0.040)	(0.036)
Observations	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260	260
R-squared	0.044	0.020	0.072	0.047	0.027	0.080	0.070	0.049	0.048	0.025	0.026	0.055	0.014	0.035	0.021	0.034	0.017	0.040	0.016	0.116
Panel B: Regressions with no multiple switchers																				
	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00
FINLOT	-0.107**	-0.109**	-0.071	-0.074	-0.098	-0.186**	-0.207**	-0.154	-0.216**	-0.147	-0.179*	-0.163*	-0.106	-0.032	-0.013	0.003	0.003	0.003	0.003	0.022
	(0.051)	(0.055)	(0.058)	(0.064)	(0.070)	(0.079)	(0.081)	(0.093)	(0.096)	(0.099)	(0.092)	(0.086)	(0.083)	(0.062)	(0.055)	(0.044)	(0.044)	(0.042)	(0.042)	(0.037)
TEACH	0.019	0.038	0.077	0.095	0.114*	0.133*	0.113	0.150	0.072	-0.049	-0.052	-0.073	-0.035	-0.057	-0.057	-0.019	-0.019	-0.019	-0.019	-0.019
	(0.051)	(0.054)	(0.057)	(0.063)	(0.069)	(0.078)	(0.080)	(0.092)	(0.094)	(0.098)	(0.090)	(0.085)	(0.082)	(0.061)	(0.054)	(0.043)	(0.043)	(0.042)	(0.042)	(0.037)
$FIN \times TEACH$	0.034	0.036	-0.003	0.020	0.064	0.168	0.185	0.024	0.142	0.274*	0.374***	0.390***	0.282**	0.159*	0.090	0.093	0.093	0.070	0.070	0.071
	(0.074)	(0.078)	(0.083)	(0.092)	(0.101)	(0.114)	(0.117)	(0.134)	(0.138)	(0.143)	(0.132)	(0.124)	(0.119)	(0.089)	(0.080)	(0.064)	(0.064)	(0.061)	(0.061)	(0.053)
Constant	0.962***	0.942***	0.904***	0.865***	0.827***	0.769***	0.769***	0.654***	0.654***	0.481***	0.346***	0.288***	0.231***	0.115***	0.096**	0.038	0.038	0.038	0.038	0.019
	(0.036)	(0.038)	(0.040)	(0.044)	(0.049)	(0.055)	(0.056)	(0.065)	(0.066)	(0.069)	(0.063)	(0.060)	(0.057)	(0.043)	(0.038)	(0.031)	(0.031)	(0.029)	(0.029)	(0.026)
Observations	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194	194
R-squared	0.037	0.039	0.033	0.037	0.052	0.094	0.089	0.053	0.050	0.025	0.057	0.065	0.043	0.022	0.011	0.026	0.026	0.016	0.016	0.033

Note: The dependent variable in all of the regressions is an indicator variable that equals 1 when the risky lottery is chosen for each of the twenty possible safe amounts (ranging from €0.50 in column (1) to €10 in column (20)). $TEACH$ and $FINLOT$ are dummy variables that equal 1 when the individual receives the *teaching* and faces the financially framed lottery, respectively. In Panel A all of the 260 observations are included in the regressions. In Panel B the sample is the same as in Table 3.3 and multiple switchers are excluded. Estimates are obtained through OLS. Standard errors in parenthesis. *** p< 0.01, ** p< 0.05, *p< 0.10.

Table 3.5: Financial Literacy and Understanding

Dependent Variable: Understanding of the fundamentals of the lottery					
	(1)	(2)	(3)	(4)	(5)
	Underst.	Underst.	Correct 1	Correct 2	Correct
FINLOT	-2.231***	-2.257***	-0.465***	-0.629***	-0.519***
	(0.374)	(0.355)	(0.072)	(0.075)	(0.070)
TEACH	-0.554	-0.586*	0.001	0.019	-0.083
	(0.374)	(0.352)	(0.072)	(0.075)	(0.069)
FINLOT$\times TEACH$	1.631***	1.739***	0.175*	0.479***	0.341***
	(0.528)	(0.505)	(0.103)	(0.107)	(0.099)
Financial Literacy (0-10)		0.045	0.041***	0.034**	0.048***
		(0.074)	(0.015)	(0.016)	(0.015)
Session FE	No	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes	Yes
Observations	260	260	260	260	260
R-squared	0.133	0.358	0.410	0.387	0.419

Note: The Table reports the OLS estimates of equation 3.2. The dependent variable in columns (1) and (2) is the self-reported understanding of the lottery (in a scale from 0 to 10). The dependent variable in the third (fourth) column is a dummy that equals 1 when the individual correctly computes the maximum (average) win from the lottery; in column (5), the dependent variable is a dummy that is equal to 1 when an individual correctly computes both the maximum and the expected win. $TEACH$ and $FINLOT$ are dummy variables that equal 1 when the individual receives the *teaching* and faces the financially framed lottery, respectively. The Controls in columns (2) to (5) include Female, Age, Work, Education dummies, Income dummies and Field-of-Study dummies. Financial Literacy equals the score of correct answers in the financial literacy survey. Session FE are dummies accounting for the different experimental rounds. Standard errors in parenthesis. *** p< 0.01, ** p< 0.05, *p< 0.10.

Table 3.6: Additional Results

Dependent Variable: Certainty equivalent of the risky lottery				
	Ambiguity Aversion		Understanding	
	(1)	(2)	(3)	(4)
FINLOT	-0.264*	-0.329**		
	(0.152)	(0.162)		
FINLOT×*Top 25% of Amb. Av.*	-0.295	-0.390		
	(0.380)	(0.430)		
Top 25% of Amb. Av.	-0.755***	-0.758**		
	(0.268)	(0.304)		
Self-Reported Underst.			0.111***	0.098**
			(0.033)	(0.040)
Controls	No	Yes	No	Yes
Observations	100	100	91	91
R-squared	0.229	0.467	0.158	0.489

Note: The dependent variable in all of the regressions is the logarithm of the certainty equivalent of the risky lottery, measured as the safe amount at which an individual stops accepting the lottery. Columns (1) and (2) reports the OLS estimates of the heterogenous effect of $FINLOT$ on the certainty equivalent depending on individual level of ambiguity aversion in the subsample of respondents that do not receive the *teaching*; columns (3) and (4) present the estimated coefficient of the self-reported understanding on the certainty equivalent in the subsample of individuals facing the *financial* lottery. $FINLOT$ is a dummy that equals 1 when the individual faces the financially framed lottery. *Top 25% of Amb. Av.* is a dummy that equals 1 for individuals in the top quartile of the distribution of ambiguity aversion. The Controls in columns (2) and (4) include Female, Age, Work, Education dummies, Income dummies and Field-of-Study dummies (plus Financial Literacy score in column (2) and $TEACH$ in column (4)). Financial Literacy equals the score of correct answers in the financial literacy survey. Standard errors in parenthesis. *** $p< 0.01$, ** $p< 0.05$, *$p< 0.10$.

3.A. Appendix

3.A.1. General Questions

Qualtrics Survey Software

PART I:
GENERAL QUESTIONS

Age:

Gender:

- Male
- Female

Highest level of education (achieved or current):

- High School diploma
- Bachelor
- Master
- PhD
- Other

Field of study (if any):

- Economics or Finance
- Accounting or Management
- Law
- Humanities
- Political Science
- Sciences or Biology
- Mathematics or Physics
- Psychology
- Medicine
- Others

Have you ever taken a Finance course during your studies?

Yes	No
○	○

Are you currently working?

Yes	No
○	○

How many years have you been working?

Approximately, what is your family net income (after taxes) per year?

- less than €20,000
- between €20,000 and €40,000
- between €40,000 and €60,000
- between €60,000 and €80,000
- between €80,000 and €100,000
- More than €100,000
- Don't know

How would you rate, on a scale from 0 to 10, your financial knowledge?

	0	1	2	3	4	5	6	7	8	9	10
Knowledge											

3.A.2. Financial Literacy Test

Qualtrics Survey Software

PART II:
FINANCIAL LITERACY TEST

Suppose you have €100 in a savings account and the interest rate is 20% per year. If you never withdraw money or interest payments, how much would you have in this account after 5 years?

More than €200	Exactly €200	Less than €200	Do not know
○	○	○	○

Imagine that the interest rate on your savings account is 1% per year and inflation is 2% per year. After 1 year, how much would you be able to buy with the money in this account?

More than today	The same as today	Less than today	Do not know
○	○	○	○

Which of the following statements is correct? If somebody buys the stock of firm B in the stock market:

- ○ He owns a part of firm B
- ○ He has lent money to firm B
- ○ He is liable for firm B's debts
- ○ None of the above;
- ○ Do not know

When an investor spreads his money among different assets, the risk of losing money:

Increases	Decreases	Stays the same	Do not know
○	○	○	○

Stocks are normally riskier than bonds. True or false?

True	False	Do not know
○	○	○

If the interest rate falls, what should happen to bond prices?

Rise	Fall	Stay the same	Do not know
○	○	○	○

When you buy a Call option on a stock, you are actually buying:

- ○ The right to sell a stock at a certain price in the future
- ○ The right to buy a stock at a certain price in the future
- ○ The obligation to sell a stock at a certain price in the future
- ○ The obligation to buy a stock at a certain price in the future
- ○ Do not know

Which of the following statements is correct? If somebody buys a bond of firm B:

- He owns a part of firm B
- He has lent money to firm B
- He is liable for firm B's debts
- None of the above;
- Do not know

Someone gives you a scratch card that allows you to win:

- €10 with probability 1/2
- €16 with probability 1/4
- €20 with probability 1/4

Compute and indicate the expected payout. If you do not know, write "Do not know".

Example: if your answer is €10, write:
"10"

If the value of an apartment increases by 5% per year and today it is worth €450,000, how much will it be worth in two years?

Indicate your answer below, in euros. If you do not know, write "Do not know".

Ex: if your answer is €20000, write:
"20000"

3.A.3. Lottery Choice

<u>**Group S: *Simple* lottery with no *teaching***</u>

PART III:
DECISION-MAKING

By completing the first two parts of the experiment you will be paid 5 euros.

Now you have the chance to earn an additional amount of money by choosing among different options in the next questions.

We offer you:

- **a safe amount of money; or**
- **the possibility of tossing a coin.**

If you opt for the coin toss, you will receive €14 if you get **head**, and €0 if you get **tail**.

You must make 20 sequential choices between tossing the coin and earning a safe amount of money. We propose you 20 possible amounts, from €0.50 to €10, as shown in the table below.

At the end of the experiment a row among the 20 will be randomly selected and your earnings will depend on the option you selected in that row. If you had chosen the coin toss, at the end of the experiment the computer will simulate the coin toss and you will be paid according to the **outcome (head or tail)**.

<u>Example:</u>

<u>in the first row, we offer you €0.50. Would you prefer the €0.50 (the safe amount) or the coin toss? And in the second row, we offer you €1, would you prefer tossing the coin or getting €1 for sure? And so on...</u>

(**YOU MUST MAKE A CHOICE IN EACH ROW!**)

	The safe amount (on the left)	Tossing the coin
€0.50	○	○
	The safe amount (on the left)	Tossing the coin
€1.00	○	○
	The safe amount (on the left)	Tossing the coin
€1.50	○	○
	The safe amount (on the left)	Tossing the coin
€2.00	○	○
	The safe amount (on the left)	Tossing the coin
€2.50	○	○
	The safe amount (on the left)	Tossing the coin
€3.00	○	○
	The safe amount (on the left)	Tossing the coin
€3.50	○	○
	The safe amount (on the left)	Tossing the coin
€4.00	○	○
	The safe amount (on the left)	Tossing the coin
€4.50	○	○
	The safe amount (on the left)	Tossing the coin

	The safe amount (on the left)	Tossing the coin
€5.00	○	○
€5.50	○	○
€6.00	○	○
€6.50	○	○
€7.00	○	○
€7.50	○	○
€8.00	○	○
€8.50	○	○
€9.00	○	○
€9.50	○	○
€10.00	○	○

How confident are you, on a scale from 0 to 10 (<u>where 0 is "I did not understand at all" and 10 is "I perfectly understood"</u>), of having fully understood the previous question?

	0	1	2	3	4	5	6	7	8	9	10
Understanding											

How much do you think one wins, on average, when tossing the coin?

	0	2	4	6	8	10	12	14	16	18	20
€											

How much do you think one can win, at most, when tossing the coin?

	0	2	4	6	8	10	12	14	16	18	20
€											

Group F: *Financial* lottery with no *teaching*

PART III:
DECISION-MAKING

By completing the first two parts of the experiment you will be paid 5 euros.

Now you have the chance to earn an additional amount of money by choosing among different options in the next questions.

We offer you:

- **a safe amount of money; or**
- **a risky financial security issued by the company AeroFlights SA.**

The financial security has a **current value** of €10 and, with 50% probability, it will yield a **net return** of 40% at the end of the experiment. With the remaining 50% probability, AeroFlights SA will **default** and the value of the security will be €0.

You must make 20 sequential choices between the security and earning a safe amount of money. We propose you 20 possible amounts, from €0.50 to €10, as shown in the table below.

At the end of the experiment a row among the 20 will be randomly selected and your earnings will depend on the option you selected in that row. If you had chosen the security, you will get its **future value** (at the end of the experiment) that will be established by a market simulator according to the afore-stated probabilities.

Example:

in the first row, we offer you €0.50. Would you prefer the €0.50 (the safe amount) or the security? And in the second row, we offer you €1, would you prefer the security or getting €1 for sure? And so on...

(**YOU MUST MAKE A CHOICE IN EACH ROW!**)

	The safe amount (on the left)	The security
€0.50	○	○
	The safe amount (on the left)	The security
€1.00	○	○
	The safe amount (on the left)	The security
€1.50	○	○
	The safe amount (on the left)	The security
€2.00	○	○
	The safe amount (on the left)	The security
€2.50	○	○
	The safe amount (on the left)	The security
€3.00	○	○
	The safe amount (on the left)	The security
€3.50	○	○

	The safe amount (on the left)	The security
€4.00	○	○
€4.50	○	○
€5.00	○	○
€5.50	○	○
€6.00	○	○
€6.50	○	○
€7.00	○	○
€7.50	○	○
€8.00	○	○
€8.50	○	○
€9.00	○	○
€9.50	○	○
€10.00	○	○

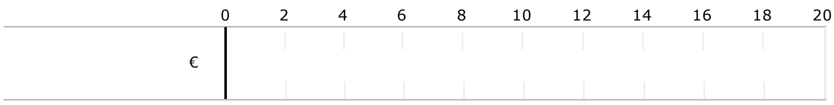
How confident are you, on a scale from 0 to 10 (where 0 is "I did not understand at all" and 10 is "I perfectly understood"), of having fully understood the previous question?

	0	1	2	3	4	5	6	7	8	9	10
Understanding											

How much do you think one wins, on average, when choosing the security?

	0	2	4	6	8	10	12	14	16	18	20
€											

How much do you think one can win, at most, when choosing the security?



<u>Group ST: *Simple* lottery with *teaching*</u>

PART III:
DECISION-MAKING

By completing the first two parts of the experiment you will be paid 5 euros.

Now you have the chance to earn an additional amount of money by choosing among different options in the next questions.

Before making your choices, please open the file "AdditionalInformation.pdf" by clicking <u>here</u>. In this file, you will find information that might be relevant and that might help when taking your choices. <u>Please read them carefully!</u>

We offer you:

- **a safe amount of money; or**
- **the possibility of tossing a coin.**

If you opt for the coin toss, you will receive €14 if you get **head**, and €0 if you get **tail**.

You must make 20 sequential choices between tossing the coin and earning a safe amount of money. We propose you 20 possible amounts, from €0.50 to €10, as shown in the table below.

At the end of the experiment a row among the 20 will be randomly selected and your earnings will depend on the option you selected in that row. If you had chosen the coin toss, at the end of the experiment the computer will simulate the coin toss and you will be paid according to the **outcome (head or tail)**.

<u>Example:</u>

<u>in the first row, we offer you €0.50. Would you prefer the €0.50 (the safe amount) or the coin toss? And in the second row, we offer you €1, would you prefer tossing the coin or getting €1 for sure? And so on...</u>

(**YOU MUST MAKE A CHOICE IN EACH ROW!)**

PS: Did you remember to open the file "AdditionalInformation.pdf"? If you think it contains information useful for your decisions and you want to re-open it, <u>here</u> it is.

[Note of the authors: the table is the same as in group S. For brevity, we omit it here.]

How confident are you, on a scale from 0 to 10 (where 0 is "I did not understand at all" and 10 is "I perfectly understood"), of having fully understood the previous question?

	0	1	2	3	4	5	6	7	8	9	10
Understanding											

How much do you think one wins, on average, when tossing the coin?

	0	2	4	6	8	10	12	14	16	18	20
€											

How much do you think one can win, at most, when tossing the coin?

	0	2	4	6	8	10	12	14	16	18	20
€											

How useful did you find, from 0 to 10, where 0 is “useless” and 10 is “crucial”, the information provided (what a security is, how to compute returns...) for your decisions?

	0	1	2	3	4	5	6	7	8	9	10
Usefulness											

Which of the information provided did you find most useful when making your choices?

- ◯ What a financial security is
- ◯ How to compute returns/future value
- ◯ What happens when the company issuing the security defaults
- ◯ None of them

<u>Group FT: *Financial* lottery with *teaching*</u>

PART III:
DECISION-MAKING

By completing the first two parts of the experiment you will be paid 5 euros.

Now you have the chance to earn an additional amount of money by choosing among different options in the next questions.

Before making your choices, please open the file "AdditionalInformation.pdf" by clicking <u>here</u>. In this file, you will find information that might be relevant and that might help when taking your choices. <u>Please read them carefully!</u>

We offer you:

- **a safe amount of money; or**
- **a risky financial security issued by the company AeroFlights SA.**

The financial security has a **current value** of €10 and, with 50% probability, it will yield a **net return** of 40% at the end of the experiment. With the remaining 50% probability, AeroFlights SA will **default** and the value of the security will be €0.

You must make 20 sequential choices between the security and earning a safe amount of money. We propose you 20 possible amounts, from €0.50 to €10, as shown in the table below.

At the end of the experiment a row among the 20 will be randomly selected and your earnings will depend on the option you selected in that row. If you had chosen the security, you will get its **future value** (at the end of the experiment) that will be established by a market simulator according to the afore-stated probabilities.

<u>Example:</u>

<u>in the first row, we offer you €0.50. Would you prefer the €0.50 (the safe amount) or the security? And in the second row, we offer you €1, would you prefer the security or getting €1 for sure? And so on...</u>

(**YOU MUST MAKE A CHOICE IN EACH ROW!)**

PS: Did you remember to open the file "AdditionalInformation.pdf"? If you think it contains information useful for your decisions and you want to re-open it, <u>here</u> it is.

[Note of the authors: the table is the same as in group F. For brevity, we omit it here.]

How confident are you, on a scale from 0 to 10 (where 0 is "I did not understand at all" and 10 is "I perfectly understood"), of having fully understood the previous question?

	0	1	2	3	4	5	6	7	8	9	10
Understanding											

How much do you think one wins, on average, when choosing the security?

	0	2	4	6	8	10	12	14	16	18	20
€											

How much do you think one can win, at most, when choosing the security?

	0	2	4	6	8	10	12	14	16	18	20
€											

How useful did you find, from 0 to 10, where 0 is “useless” and 10 is “crucial”, the information provided (what a security is, how to compute returns...) for your decisions?

	0	1	2	3	4	5	6	7	8	9	10
Usefulness											

Which of the information provided did you find most useful when making your choices?

- What a financial security is
- How to compute returns/future value
- What happens when the company issuing the security defaults
- None of them

Ambiguous Lottery

Finally, we present you the last question, where you have the chance to earn some extra money.

We offer you:

- a safe amount of money; or
- the possibility of drawing a ball from a box containing 10 balls;

The box contains green and blue balls in **unknown proportions**. If you draw a **green** ball from the box, you earn €5, if you draw a **blue** ball from the box, your get €0.

You must make 20 successive choices between drawing a ball or earning a safe amount of money. We propose you 20 possible amounts, from €0.25 to €5, as shown in the table below.

At the end of the experiment a row among the 20 will be randomly selected and your earnings will depend on the option you selected in that row. If you had chosen to draw a ball, at the end of the experiment the computer will simulate the draw, and you will be paid according to the **color** of the ball you get (green or blue).

Example:

in the first row, we offer you €0.25. Would you prefer the €0.25 (the safe amount) or drawing a ball? And in the second row, we offer you €0.50, would you prefer drawing a ball or getting €0.50 for sure? And so on…

(**YOU MUST MAKE A CHOICE IN EACH ROW!**)

	The Safe Amount (on the left)	Drawing a ball
€ 0.25	○	○
€ 0.50	○	○
€ 0.75	○	○
€ 1	○	○
€ 1.25	○	○
€ 1.50	○	○
€ 1.75	○	○
€ 2	○	○
€ 2.25	○	○
€ 2.50	○	○
€ 2.75	○	○
€ 3	○	○
€ 3.25	○	○
€ 3.50	○	○
€ 3.75	○	○
€ 4	○	○
€ 4.25	○	○
€ 4.50	○	○
€ 4.75	○	○
€ 5	○	○

3.A.4. The Teaching

1. What is a financial security?

A security is a financial instrument, as for instance a stock or a bond, that can be traded in financial markets and whose value depends on the characteristics of the issuing company.

2. How do you compute the future value of a security, given the rate of return?

The **future value** of the security can be determined knowing its **rate of return**.

By multiplying the rate of return by the current value, you will know the return of the security, that is, the increase in its value over time.

Therefore, the **future value** of a financial security will simply be the sum of its current value plus the return.

Here you have a brief example:
If a security has a current value of 1000 euros, and its rate of return is 30%, the return will be: $1000 \times 30\% = 300$ euros. The future value of the security will be $1000 + 300 = 1300$ euros.

However, this will happen only if the company does not fail.

3. What happens if the issuer company defaults?

When the issuer company defaults, the financial security will loose all of its value and therefore its future value will be **zero**.

Bibliography

Acharya, V. V., Eisert, T., Eufinger, C., and Hirsch, C. (2014). Real Effects of the Sovereign Debt Crisis in Europe: Evidence from Syndicated Loans. CEPR Discussion Papers No. 10108, Centre for Economic Policy Research.

Acharya, V. V. and Yorulmazer, T. (2008). Cash-in-the-Market Pricing and Optimal Resolution of Bank Failures. *Review of Financial Studies*, 21(6):2705–2742.

Adelino, M., Cunha, I., and Ferreira, M. (2017). The Economic Effects of Public Financing: Evidence from Municipal Bond Ratings Recalibration. *Review of Financial Studies*, forthcoming.

Afonso, A., Arghyrou, M. G., and Kontonikas, A. (2015). The Determinants of Sovereign Bond Yield Spreads in the EMU. ECB Working Paper No. 1781, European Central Bank.

Almenberg, J. and Dreber, A. (2015). Gender, Stock Market Participation and Financial Literacy. *Economics Letters*, 137(C):140–142.

Almenberg, J. and Säve-Söderbergh, J. (2011). Financial Literacy and Retirement Planning in Sweden. *Journal of Pension Economics and Finance*, 10(04):585–598.

Altavilla, C., Pagano, M., and Simonelli, S. (2017). Bank Exposures and Sovereign Stress Transmission. *Review of Finance*, forthcoming.

Anderson, R. W. (2011). Ownership and Control in Bail-in and Special Resolution. Discussion note, London School of Economics FMG Workshop on the Design of Bail-in Arrangements and Special Resolution Regimes.

Arrondel, L., Debbich, M., and Savignac, F. (2015). Does Financial Literacy Influence Financial Decisions? *Rue de la Banque No.*, (02).

Arslanalp, S. and Poghosyan, T. (2016). Foreign Investor Flows and Sovereign Bond Yields in Advanced Economies. *Journal of Banking and Financial Economics*, 2(6):45–67.

Association for Financial Markets in Europe (2010). The Systemic Safety Net: Pulling Failing Firms Back From the Edge. Discussion note, AFME.

Atkinson, A. and Messy, F.-A. (2012). Measuring Financial Literacy: Results of the OECD / International Network on Financial Education (INFE) Pilot Study. OECD Working Paper on Finance, Insurance and Private Pensions No. 15, OECD.

Avdjiev, S., Hardy, B., Kalemli-Ozcan, S., and Servén, L. (2017). Gross Capital Inflows to Banks, Corporates and Sovereigns. NBER Working Paper No. 23116, National Bureau of Economic Research.

Avgouleas, E. and Goodhart, C. A. (2014). A Critical Evaluation of Bail-in as a Bank Recapitalisation Mechanism. CEPR Discussion Paper No. 10065, Centre for Economic Policy Research.

Barberis, N., Shleifer, A., and Wurgler, J. (2005). Comovement. *Journal of Financial Economics*, 75(2):283–317.

Becker, B. and Ivashina, V. (2014). Financial Repression in the European Sovereign Debt Crisis. CEPR Discussion Paper No. DP12185, Centre for Economic Policy Research.

Bernard, B., Capponi, A., and Stiglitz, J. E. (2017). Bail-ins and bail-outs: Incentives, connectivity, and systemic stability. NBER Working Paper No. 23747, National Bureau of Economic Research.

Bernheim, B. D. (1995). Do Households Appreciate their Financial Vulnerabilities? An Analysis of Actions, Perceptions, and Public Policy. *Tax Policy and Economic Growth*, pages 1–30.

Bernheim, B. D. (1998). Financial Illiteracy, Education, and Retirement Saving. PRC Working Paper No. 96-7, Wharton School Pension Research Council, University of Pennsylvania.

Bernheim, B. D., Garrett, D. M., and Maki, D. M. (2001). Education and Saving:: The Long-term Effects of High School Financial Curriculum Mandates. *Journal of Public Economics*, 80(3):435–465.

Blanchard, O., Ostry, J. D., Ghosh, A. R., and Chamon, M. (2015). Are Capital Inflows Expansionary or Contractionary? Theory, Policy Implications, and Some Evidence. NBER Working Paper No. 21619, National Bureau of Economic Research.

Broner, F., Gelos, G., and Reinhart, C. (2006). When in Peril, Retrench: Testing the Portfolio Channel of Contagion. *Journal of International Economics*, 69(1):203–230.

Broner, F. A., Lorenzoni, G., and Schmukler, S. L. (2013). Why Do Emerging Economies Borrow Short Term? *Journal of the European Economic Association*, 11(01):67–100.

Brown, M., Grigsby, J., van der Klaauw, W., Wen, J., and Zafar, B. (2016). Financial Education and the Debt Behavior of the Young. *Review of Financial Studies*, 29(9):2490–2522.

Brugiavini, A., Cavapozzi, D., Padula, M., and Pettinicchi, Y. (2015). Financial Education, Literacy and Investment Attitudes. SAFE Working Paper No. 86, Research Center SAFE - Sustainable Architecture for Finance in Europe, Goethe University Frankfurt.

Bucher-Koenen, T. and Lusardi, A. (2011). Financial Literacy and Retirement Planning in Germany. *Journal of Pension Economics and Finance*, 10(04):565–584.

Calderon, C. and Kubota, M. (2012). Gross Inflows Gone Wild : Gross Capital Inflows, Credit Booms and Crises. Policy Research Working Paper No. 6270, The World Bank.

Calomiris, C. W. (2011). Incentive-Robust Financial Reform. *Cato Journal*, 31(3):561–589.

Calvet, L. E., Campbell, J. Y., and Sodini, P. (2007). Down or Out: Assessing the Welfare Costs of Household Investment Mistakes. *Journal of Political Economy*, 115(5):707–747.

Calvet, L. E., Campbell, J. Y., and Sodini, P. (2009). Measuring the Financial Sophistication of Households. *American Economic Review*, 99(2):393–398.

Campbell, J. Y. (2006). Household Finance. *Journal of Finance*, 61(4):1553–1604.

Chang, Y.-C., Hong, H., and Liskovich, I. (2014). Regression Discontinuity and the Price Effects of Stock Market Indexing. *Review of Financial Studies*, 28(1):212–246.

Chari, V. V. and Kehoe, P. J. (2016). Bailouts, Time Inconsistency, and Optimal Regulation: A Macroeconomic View. *American Economic Review*, 106(9):2458–93.

Chen, H., Noronha, G., and Singal, V. (2004). The Price Response to S&P 500 Index Additions and Deletions: Evidence of Asymmetry and a New Explanation. *Journal of Finance*, 59(4):1901–1930.

Choi, J. J., Laibson, D., and Madrian, B. C. (2011). $100 bills on the sidewalk: Suboptimal investment in 401 (k) plans. *Review of Economics and Statistics*, 93(3):748–763.

Christelis, D., Jappelli, T., and Padula, M. (2010). Cognitive Abilities and Portfolio Choice. *European Economic Review*, 54(1):18–38.

Christiansen, C., Joensen, J. S., and Rangvid, J. (2008). Are Economists More Likely to Hold Stocks? *Review of Finance*, 12(3):465–496.

Claessens, S. and Yafeh, Y. (2013). Comovement of Newly Added Stocks with National Market Indices: Evidence from Around the World. *Review of Finance*, 17(1):203–227.

Cole, S., Paulson, A., and Shastry, G. (2014). Smart Money? The Effect of Education on Financial Outcomes. *Review of Financial Studies*, 27(7):2022–2051.

Collins, J. M. (2013). The Impacts of Mandatory Financial Education: Evidence from a Randomized Field Study. *Journal of Economic Behavior & Organization*, 95(C):146–158.

Cordella, T. and Yeyati, E. L. (2003). Bank Bailouts: Moral Hazard vs. Value Effect. *Journal of Financial Intermediation*, 12(4):300–330.

Cremers, M., Ferreira, M. A., Matos, P., and Starks, L. (2016). Indexing and Active Fund Management: International Evidence. *Journal of Financial Economics*, 120(3):539–560.

Cremers, M. and Petajisto, A. (2009). How Active Is Your Fund Manager? A New Measure That Predicts Performance. *Review of Financial Studies*, 22(9):3329–3365.

Dell'Erba, S., Hausmann, R., and Panizza, U. (2013). Debt Levels, Debt Composition, and Sovereign Spreads in Emerging and Advanced Economies. *Oxford Review of Economic Policy*, 29(3):518–547.

Diamond, D. W. and Rajan, R. G. (2005). Liquidity Shortages and Banking Crises. *Journal of Finance*, 60(2):615–647.

Dimmock, S. G., Kouwenberg, R., Mitchell, O. S., and Peijnenburg, K. (2016). Ambiguity Aversion and Household Portfolio Choice Puzzles: Empirical Evidence. *Journal of Financial Economics*, 119(3):559 – 577.

Drexler, A., Fischer, G., and Schoar, A. (2014). Keeping It Simple: Financial Literacy and Rules of Thumb. *American Economic Journal: Applied Economics*, 6(2):1–31.

Duflo, E. and Saez, E. (2003). The Role of Information and Social Interactions in Retirement Plan Decisions: Evidence from a Randomized Experiment. *The Quarterly Journal of Economics*, 118(3):815–842.

European Commission (2014). EU Bank Recovery and Resolution Directive (BRRD): Frequently Asked Questions. Memo, issued by the European Commission on 15^{th} April.

Farhi, E. and Tirole, J. (2012). Collective Moral Hazard, Maturity Mismatch, and Systemic Bailouts. *American Economic Review*, 102(1):60–93.

Federal Deposit Insurance Company and Bank of England (2012). Resolving Globally Active, Systematically Important, Financial Institutions. Discussion paper, FDIC and Bank of England.

Fornero, E. and Monticone, C. (2011). Financial Literacy and Pension Plan Participation in Italy. *Journal of Pension Economics and Finance*, 10(04):547–564.

Fort, M., Manaresi, F., and Trucchi, S. (2016). Adult Financial Literacy and Households' Financial Assets: the Role of Bank Information Policies. *Economic Policy*, 31(88):743–782.

Freixas, X. (2000). Optimal Bail Out Policy, Conditionality and Constructive Ambiguity. DNB Staff Reports (discontinued), Netherlands Central Bank.

Freixas, X., Parigi, B. M., and Rochet, J.-C. (2000). Systemic Risk, Interbank Relations, and Liquidity Provision by the Central Bank. *Journal of Money, Credit and Banking*, 32(3):611–638.

Freixas, X., Parigi, B. M., and Rochet, J.-C. (2004). The Lender of Last Resort: A Twenty-First Century Approach. *Journal of the European Economic Association*, 2(6):1085–1115.

Gartner, K. and Todd, R. M. (2005). Effectiveness of Online Early Intervention Financial Education Programs for Credit-card Holders. Proceedings 962, Federal Reserve Bank of Chicago.

Gaudecker, H.-M. v. (2015). How Does Household Portfolio Diversification Vary with Financial Literacy and Financial Advice? *The Journal of Finance*, 70(2):489–507.

Gennaioli, N., Martin, A., and Rossi, S. (2014). Sovereign Default, Domestic Banks, and Financial Institutions. *Journal of Finance*, 69(2):819–866.

Ghirardato, P., Maccheroni, F., and Marinacci, M. (2004). Differentiating Ambiguity and Ambiguity Attitude. *Journal of Economic Theory*, 118(2):133–173.

Gonzalez-Rozada, M. and Yeyati, E. L. (2008). Global Factors and Emerging Market Spreads. *Economic Journal*, 118(533):1917–1936.

Greenwood, R. (2005). Short and Long-term Demand Curves for Stocks: Theory and Evidence on the Dynamics of Arbitrage. *Journal of Financial Economics*, 75(3):607–649.

Greenwood, R. and Vayanos, D. (2010). Price Pressure in the Government Bond Market. *American Economic Review*, 100(2):585–590.

Guiso, L. and Jappelli, T. (2009). Financial Literacy and Portfolio Diversification. CSEF Working Paper No. 212, Centre for Studies in Economics and Finance, University of Naples.

Haliassos, M., Jansson, T., and Karabulut, Y. (2017). Financial Literacy Externalities. CEPR Discussion Paper No. DP12100, Centre for Economic Policy Research.

Harris, L. and Gurel, E. (1986). Price and Volume Effects Associated with Changes in the S&P 500 List: New Evidence for the Existence of Price Pressures. *Journal of Finance*, 41(4):815–29.

Hastings, J. S., Madrian, B. C., and Skimmyhorn, W. L. (2013). Financial Literacy, Financial Education, and Economic Outcomes. *Annual Review of Economics*, 5(1):347–373.

Hau, H. (2011). Global versus Local Asset Pricing: A New Test of Market Integration. *Review of Financial Studies*, 24(12):3891–3940.

Hau, H., Massa, M., and Peress, J. (2010). Do Demand Curves for Currencies Slope Down? Evidence from the MSCI Global Index Change. *Review of Financial Studies*, 23(4):1681–1717.

Hilgert, M. A., Hogarth, J. M., and Beverly, S. G. (2003). Household Financial Management: the Connection Between Knowledge and Behavior. *Federal Reserve Bulletin*, pages 309–322.

Holmstrom, B. and Tirole, J. (1997). Financial Intermediation, Loanable Funds, and The Real Sector. *The Quarterly Journal of Economics*, 112(3):663–691.

Holt, C. A. and Laury, S. K. (2002). Risk Aversion and Incentive Effects. *American Economic Review*, 92(5):1644–1655.

Huertas, T. F. (2013). The Case for Bail-Ins. In A. Dombret and P.S. Kenadjianin (ed), *The Bank Recovery and Resolution Directive*, Berlin, Boston: De Gruyter.

Jappelli, T. and Padula, M. (2013). Investment in Financial Literacy and Saving Decisions. *Journal of Banking & Finance*, 37(8):2779–2792.

Jotikasthira, C., Lundblad, C., and Ramadorai, T. (2012). Asset Fire Sales and Purchases and the International Transmission of Funding Shocks. *Journal of Finance*, 67(6):2015–2050.

Kaufman, G. G. (1991). Lender of Last Resort: A Contemporary Perspective. *Journal of Financial Services Research*, 5(2):95–110.

Kimball, M. and Shumway, T. (2006). Investor Sophistication, and the Participation, Home Bias, Diversification, and Employer Stock Puzzles. Mimeo, University of Michigan.

Klapper, L., Lusardi, A., and Panos, G. A. (2013). Financial Literacy and its Consequences: Evidence from Russia During the Financial Crisis. *Journal of Banking & Finance*, 37(10):3904–3923.

Klapper, L. and Panos, G. A. (2011). Financial Literacy and Retirement planning: the Russian Case. *Journal of Pension Economics and Finance*, 10(04):599–618.

Klibanoff, P., Marinacci, M., and Mukerji, S. (2005). A Smooth Model of Decision Making under Ambiguity. *Econometrica*, 73(6):1849–1892.

Landier, A. and Ueda, K. (2009). The Economics of Bank Restructuring; Understanding the Options. IMF Staff Position Note No. 2009/12, International Monetary Fund.

Lane, P. R. and McQuade, P. (2014). Domestic Credit Growth and International Capital Flows. *The Scandinavian Journal of Economics*, 116(1):218–252.

Levy-Yeyati, E. and Williams, T. (2012). Emerging economies in the 2000s: Real decoupling and financial recoupling. *Journal of International Money and Finance*, 31(8):2102–2126.

Lusardi, A. and de Bassa Scheresberg, C. (2013). Financial Literacy and High-Cost Borrowing in the United States. NBER Working Paper No. 18969, National Bureau of Economic Research.

Lusardi, A., Michaud, P.-C., and Mitchell, O. S. (2017). Optimal Financial Knowledge and Wealth Inequality. *Journal of Political Economy*, 125(2):431–477.

Lusardi, A. and Mitchell, O. S. (2007a). Baby Boomer Retirement Security: The Roles of Planning, Financial Literacy, and Housing Wealth. *Journal of Monetary Economics*, 54(1):205–224.

Lusardi, A. and Mitchell, O. S. (2007b). Financial Literacy and Retirement Preparedness: Evidence and Implications for Financial Education. *Business Economics*, 42(1):35–44.

Lusardi, A. and Mitchell, O. S. (2010). How Ordinary Consumers Make Complex Economic Decisions: Financial Literacy and Retirement Readiness. CFS Working Paper No. 2010/11, Center for Financial Studies (CFS).

Lusardi, A. and Mitchell, O. S. (2011a). Financial Literacy and Planning: Implications for Retirement Wellbeing. NBER Working Paper No. 17078, National Bureau of Economic Research.

Lusardi, A. and Mitchell, O. S. (2011b). Financial Literacy and Retirement Planning in the United States. *Journal of Pension Economics and Finance*, 10(04):509–525.

Lusardi, A. and Mitchell, O. S. (2014). The Economic Importance of Financial Literacy: Theory and Evidence. *Journal of Economic Literature*, 52(1):5–44.

Lusardi, A. and Tufano, P. (2015). Debt Literacy, Financial Experiences, and Overindebtedness. *Journal of Pension Economics and Finance*, 14(04):332–368.

Lührmann, M., Serra-Garcia, M., and Winter, J. (2015). Teaching Teenagers in Finance: Does it Work? *Journal of Banking & Finance*, 54(C):160–174.

Mailath, G. J. and Mester, L. J. (1994). A Positive Analysis of Bank Closure. *Journal of Financial Intermediation*, 3(3):272–299.

Mendicino, C., Nikolov, K., and Suarez, J. (2017). Equity versus Bail-in Debt in Banking: An Agency Perspective. CEPR Discussion Paper No. 12104, Centre for Economic Policy Research.

Mendoza, E. and Terrones, M. (2012). An Anatomy of Credit Booms and their Demise. Working Paper No. 670, Central Bank of Chile.

Moore, D. L. (2003). *Survey of Financial Literacy in Washington State: Knowledge, Behavior, Attitudes, and Experiences*. Washington State Department of Financial Institutions.

Peiris, S. J. (2013). Foreign Participation in Local Currency Bond Markets of Emerging Economies. *Journal of International Commerce, Economics and Policy*, 04(03):1–15.

Raddatz, C. and Schmukler, S. (2012). On the International Transmission of Shocks: Micro-evidence from Mutual Fund Portfolios. *Journal of International Economics*, 88(2):357–374.

Raddatz, C., Schmukler, S., and Williams, T. (2017). International Asset Allocations and Capital Flows: The Benchmark Effect. *Journal of International Economics*, forthcoming.

Ratnovski, L. and Dell'Ariccia, G. (2012). Bailouts, Contagion, and Bank Risk-Taking. 2012 Meeting Papers 133, Society for Economic Dynamics.

Repullo, R. (2005). Liquidity, Risk Taking, and the Lender of Last Resort. *International Journal of Central Banking*, 1(2):47–80.

Rutledge, V. S., Moore, M., Dobler, M., Bossu, W., Jassaud, N., and Zhou, J. (2012). From Bail-out to Bail-in; Mandatory Debt Restructuring of Systemic Financial Institutions. IMF Discussion Note No. 12/03, International Monetary Fund.

Sayinzoga, A., Bulte, E. H., and Lensink, R. (2016). Financial Literacy and Financial Behaviour: Experimental Evidence from Rural Rwanda. *The Economic Journal*, 126(594):1571–1599.

Schäfer, A., Schnabel, I., and Weder di Mauro, B. (2016). Bail-in Expectations for European Banks: Actions Speak Louder than Words. CEPR Discussion Paper No. 11061, Centre for Economic Policy Research.

Sekita, S. (2011). Financial Literacy and Retirement Planning in Japan. *Journal of Pension Economics and Finance*, 10(04):637–656.

Servon, L. J. and Kaestner, R. (2008). Consumer Financial Literacy and the Impact of Online Banking on the Financial Behavior of Lower-Income Bank Customers. *Journal of Consumer Affairs*, 42(2):271–305.

Shleifer, A. (1986). Do Demand Curves for Stocks Slope Down? *Journal of Finance*, 41(3):579–90.

Song, C. (2015). Financial Illiteracy and Pension Contributions: A Field Experiment on Compound Interest in China. Mimeo, University of California, Berkeley.

Vagias, D. and Van Dijk, M. A. (2011). International Capital Flows and Liquidity. Mimeo, Rotterdam School of Management.

van Rooij, M., Lusardi, A., and Alessie, R. (2011a). Financial Literacy and Stock Market Participation. *Journal of Financial Economics*, 101(2):449–472.

van Rooij, M. C., Lusardi, A., and Alessie, R. J. (2011b). Financial Literacy and Retirement Planning in the Netherlands. *Journal of Economic Psychology*, 32(4):593–608.

Vayanos, D. and Vila, J.-L. (2009). A Preferred-Habitat Model of the Term Structure of Interest Rates. CEPR Discussion Paper No. 7547, Centre for Economic Policy Research.

Vayanos, D. and Woolley, P. (2013). An Institutional Theory of Momentum and Reversal. *Review of Financial Studies*, 26(5):1087–1145.

Warnock, F. and Warnock, V. (2009). International Capital Flows and U.S. Interest Rates. *Journal of International Money and Finance*, 28:903–919.

Williams, T. (2017). Capital Inflows, Sovereign Debt and Bank Lending: Micro-Evidence from an Emerging Market. Working Paper No. 2017-12, The George Washington University, Institute for International Economic Policy.