DEPARTMENT OF ECONOMICS

Essays on the Determinants of Households and Firms' Investment Choices

Elena Lazzaro

Thesis submitted for assessment with a view to obtaining the degree of Doctor of Economics of the European University Institute

Florence, 02 July 2024

European University Institute
Department of Economics

Essays on the Determinants of Households and Firms' Investment Choices

Elena Lazzaro

Thesis submitted for assessment with a view to
obtaining the degree of Doctor of Economics
of the European University Institute

Examining Board

Prof. Russell Cooper, EUI, Supervisor
Prof. Giacomo Calzolari, EUI, Co-Supervisor
Prof. Zhen Liu, Federal Bank of San Francisco
Prof. Alexandros Fakos, Istituto Tecnológico Autónomo de México

© Elena Lazzaro, 2024

No part of this thesis may be copied, reproduced or transmitted without prior permission of the author

Researcher declaration to accompany the submission of written work
Department Economics - Doctoral Programme

I Elena Lazzaro certify that I am the author of the work "Essays on the Determinants of Households and Firms' Investment Choices" I have presented for examination for the Ph.D. at the European University Institute. I also certify that this is solely my own original work, other than where I have clearly indicated, in this declaration and in the thesis, that it is the work of others.

I warrant that I have obtained all the permissions required for using any material from other copyrighted publications.

I certify that this work complies with the Code of Ethics in Academic Research issued by the European University Institute (IUE 332/2/10 (CA 297).

The copyright of this work rests with its author. Quotation from it is permitted, provided that full acknowledgement is made. This work may not be reproduced without my prior written consent. This authorisation does not, to the best of my knowledge, infringe the rights of any third party.

I declare that this work consists of 31874 words.

Statement of inclusion of previous work:

I confirm that chapter 2 was jointly co-authored with Elena Romito and I contributed 75% of the work.
I confirm that chapter 3 was jointly co-authored with Tuna Dökmeci and I contributed 50% of the work.

Signature and date:

16.04.2024

To my beloved grandparents Laura and Alessandro,
for being a constant source of support and inspiration,
and for always being by my side.

Acknowledgements

There are many people for whom I am grateful, and who have made a significant contribution to both my thesis and my life over the past four years.

First and foremost, I would like to express my sincere gratitude to Russell Cooper, for his unwavering support, invaluable guidance, and insightful advice throughout this journey. He has been the best supervisor I could have asked for. His kindness and empathy have not only made every step more meaningful and enjoyable but have also greatly contributed to my personal and professional development. I have learned a lot from him, both as a professor and as a human being, and I hope that our relationship will continue to thrive.

I would also like to thank Giacomo Calzolari for his insightful contributions and for sharing his precious experience with me. His kindness, preparation, and professionalism make him an exceptional supervisor, and I am grateful that he has been part of my experience.

My thanks also go to all the professors at EUI from whom I have had the pleasure of learning over the years. In particular, I would like to thank Laurent Mathevet for all the time he has dedicated to me, for his patience, and for the suggestions and teachings he has shared with me. Furthermore, I would like to thank Fabrizia Mealli, for being not only an excellent researcher and teacher but also a wonderful person, always willing to help others.

Furthermore, like many before me, I cannot help but acknowledge the invaluable contribution that the EUI community has had on this journey. Pursuing a PhD is not always a straight path, but rather a journey full of twists and turns, testing your limits and making you confront the fear of failure. I wish every current and future PhD student to be as fortunate as I have been and to have the opportunity to live this adventure surrounded by kind, intelligent, and fun people. I extend my heartfelt gratitude to all my classmates not only for being outstanding friends and researchers, but also for infusing this experience with laughter and joy. I would like to thank Sarah, Lucia, Martina, Cécile, Antonella, Loredana, and Maurizio for their invaluable and unwavering contributions. Your presence brings light and comfort to the institute, and we are immensely grateful for all that you do.

I want to extend a special thanks to my friend and colleague, Edoardo Frattola, for his invaluable support over the years. From sharing laughs on the balcony to tackling exams and papers together, his contribution as both a researcher and friend has meant the world to me. I would also like to express my appreciation to Riccardo Pesci and Harvey Stafford for their valuable friendship, for all the laughter, and for making these years memorable. Lastly, I cannot thank my friend and co-author Tuna Dökmeci enough. She is not only an amazing researcher but also a precious friend and one of the people I value the most.

However, this thesis is not only the result of the incredible technical and emotional support from the people at EUI, but also a result of the love and support from my loved ones outside. I express my gratitude to my mother, Livia, for teaching me the importance of fighting for my dreams and for being an example of strength, perseverance, and for being that embrace that never leaves me. I would like to thank my father, Paolo, for being an endless source of joy and enthusiasm towards life, for teaching me the importance of remaining calm, even during a storm. Thanks to my dear sister Sofia, you embody a rare combination of stubbornness, humor, intelligence, and sweetness. I am incredibly fortunate to have you as a sister, and I hope to always make you proud, just as I am proud of you.

A heartfelt thanks goes to my grandparents Laura and Alessandro. Without their unwavering support, I wouldn't be where I am today. They have been my twin pillars, providing me with strength and guidance every step of the way. Their enduring love has shaped me into the person I am, and I owe all my successes to them. Their constant encouragement and belief in me have made everything possible, and there are no words to say how much I am grateful for having them in my life.

My sincerest gratitude also goes to my lifelong friends, who, although distant, have been a constant presence over the years. I cannot express enough gratitude to Anna for being a true friend and for all the help and laughter she has provided throughout this journey. From the bottom of my heart, I would like to thank my anchor outside the doctoral program, Fedele, for being my person, safe place, and lifelong support.

Finally, I would like to express my gratitude to all the new friends I met at the Bank of Italy. Thank you for welcoming me, caring about me, and supporting me from the first day. You have not just been colleagues but friends. In particular, I would like to thank Raffaello Bronzini, Alessandro Pietropaoli, Elena Romito, Daniele Ruggeri, and Elisa Scarinzi, for the patience, kindness, and experience they have shared with me in these months.

Abstract

Chapter 1 develops a theoretical model highlighting how the signaling effect of government subsidies for R&D has a heterogeneous impact over time and across firms depending on their financial constraints. The model shows that all firms might immediately benefit from a reduction in the cost of debt ("certification effect") independently of their initial capital. The strength of this effect depends on the screening ability of the government compared to the banks. Nonetheless, even without the certification effect, the subsidy directly eases firms' financial constraints by providing additional funds ("resource effect"). The combination of these effects allows firms with less investment capacity to invest and use their project's success to signal their quality to the market, thus paying a lower cost of debt for future projects ("reputation effect").

In Chapter 2 (joint with Elena Romito), we test the theoretical predictions of Chapter 1 on a sample of Italian firms using a Sharp-RDD. The results indicate that the reputation effect reduces the cost of debt of subsidized firms by 1.3 percentage points. However, we do not find strong evidence in favor of the certification effect.

Chapter 3 (joint with Tuna Dökmeci) studies the effect of children's job insecurity on their parents' consumption and labor decisions. Using SHIW data and a Difference-in-Difference approach, we estimate this relationship exploiting a firm-size discontinuity introduced by the "Fornero" labor market reform. According to our findings, working parents reduce their consumption by €2,453 per year. Such decrease is mainly driven by a reduction in durable expenses, which decline by €1,600 annually. Even if we do not find any strong effect on the intensive and extensive margin of labor, the study shows that the savings behavior differs depending on the parents' working status: retired parents not only cut their durable expenses but also reduced their current expenditures.

Table of Contents

Chapter 1

R&D subsidies and firms' access to external funds: A theoretical approach

Abstract

This paper provides a theoretical analysis of the influence of a public R&D subsidy on firms' access to bank loans. It highlights how the effect might be persistent over time, shaping the investment decisions of the firms with less capital. When the subsidy is assigned through an ex-ante screening procedure, the government's decision to grant funding can serve as both a signal of a project's quality ("certification effect") and alleviate the firm's financial constraints by directly providing additional resources ("resource effect"). Furthermore, firms with less initial capital could also obtain funds at a lower cost in the next period using the development of the project as a signal of their quality ("reputation effect").

1.1 Introduction

Information asymmetry in financial markets is a significant obstacle that firms face when seeking external funding. When external financiers are unable to assess a project's quality accurately, the cost of obtaining funds is adjusted to account for this uncertainty. However, this heightened cost of funds may be prohibitive for many firms.

This challenge is particularly pronounced in the case of R&D investments as these are inherently more volatile and risky. Many business surveys report that the lack of external finance is the major obstacle to their investment and innovation activities (Harhoff and Körting [1998], Carpenter and Petersen [2002], Himmelberg and Petersen [1994], Kamien and Schwartz [1978], Spence [1979]). In cases where firms are unable to secure the necessary external funding for project development, they may opt to delay the project, thus potentially resulting in a loss in terms of innovative outcomes. Several studies delve into strategies for mitigating this informational asymmetry. Such approaches include mechanisms like informational sharing among banks and utilizing emerging technologies. Another potential way to alleviate this market failure is through public signals, like government awarding or certificates.

Some authors find evidence in favor of how government subsidy might help firms to attract external funds (Lerner [2000]), both in the forms of equity or venture capital (Feldman and Kelley [2006], Howell [2017]) or through access to the bank credit market (Meuleman and De Maeseneire [2012], Wei and Zuo [2018], Hottenrott, Lins, and Lutz [2018] and Li, R. P. Lee, and Wan [2020]).

This study contributes to the existing theoretical literature, highlighting how the signaling effect of the subsidy program has a heterogeneous impact over time and across firms depending on their financial constraints. The model shows that all firms might immediately benefit from a reduction in the cost of debt ("certification effect") independently of their initial capital level and that the strength of this potential reduction depends on the relative screening ability of the government compared to the banks. Nonetheless, even in the absence of the certification effect, the subsidy directly eases firms' financial constraints by providing additional funds ("resource effect"). The combination of these effects will have two different consequences depending on firms' capital availability: for firms with high investment capacity, this will simply increase their profits, while for firms who would not have been able to undertake such

projects due to their high costs, this might change their decisions. In the following period, these firms can now use the project's success to signal their quality to the market and thus pay a lower cost of debt for other future projects ("reputation effect"). In other words, while the certification and resource effect can be considered as direct effects of the subsidy, the reputation effect arises for those firms that, due to the high level of information asymmetry in the market, cannot afford the development of the project, and therefore decide to delay their investments. Successfully developing an R&D project might help them build a reputation, disclosing additional information about their type and thus reducing the cost of financing.

To achieve this objective, the paper employs various specifications of the same game, ranging from the simplest to more complex formulations. Initially, a static game is constructed with continuous types to describe how the imperfect screening abilities of banks can lead to distortions in firms' investment decisions. This section offers intuitive insights into the differences between scenarios with complete and incomplete information. I then move to a two-type game to show how the government subsidy for R&D can *directly* lower the cost of debt and help firms to invest. In the latter part of the paper, a dynamic game with discrete types is introduced to underscore that government subsidies may exert not only a direct effect but also an indirect one, which gains its importance over time.

The paper is structured in the following way. Section 1.2 summarizes the literature review and highlights the primary contributions of this study. Section 1.3 presents the outcomes of the Static Game, both in the continuous and discrete type scenarios. Moving forward, Section 1.4 delineates the equilibrium in the Dynamic Game, while Section 1.5 concludes the paper.

1.2 Literature Review

Signaling theory is by no means an uncharted territory in economics. Many scholars have used it to understand the performance implications of different sources of signals. For instance, in his seminal paper, Akerlof [1978] points out that when goods of different qualities are traded in the same market, if buyers are not able to distinguish between "good" and "bad" products, there will be a reduction in the size of the market and also in the average quality of goods. The author also highlights that this situation often happens in a market where social and private returns differ, providing a theoretical justification for government intervention.

A more recent theoretical work on the topic is that of Takalo and Tanayama [2010], who analyze the role of R&D subsidies in lessening adverse selection. Asymmetric information about the quality of an innovation project between the entrepreneur and the financier leads to a higher cost of external than internal capital, creating a funding gap. Their findings suggest that, under specific conditions, public R&D subsidies have the potential to alleviate these financing constraints. They emphasize that when the subsidy allocation is not arbitrary but follows a screening process, government funding decisions reduce information asymmetry. In a static context, they establish a mixed-strategy equilibrium in which the government screens projects with a positive probability; according to their findings, firms reap benefits from government subsidy, deriving advantages from both the certification and resource effects.

Also Kleer [2010] developed a novel model on this subject. The author studied the impact of a government subsidy as a signal to private investors, assuming the existence of two kinds of R&D projects: basic research projects with little private but high social returns (preferred by the government) and applied research projects with high private but little social returns (preferred by private investors). The government screens projects and observes their types, and then decides to grant a subsidy. Banks only observe the government's decision but not the project type and decide whether to finance the projects. They consider two different scenarios, depending on whether the government's subsidy gives a quality signal. If the government allocates the subsidies through a pre-screening procedure, the signal is socially beneficial since it reveals the quality of the project.

This paper builds upon their work by delving into the analysis in different ways. Firstly, it extends the analysis into a dynamic game, shedding light on the presence of a reputation effect for firms with less financial means. Like their findings, I demonstrate that government subsidies facilitate firms' access to credit immediately after receiving the grant, irrespective of their initial capital. However, this study emphasizes the heterogeneous nature of this effect across firms of varying available capital, both in static and dynamic settings. In the static game, government assistance potentially reduces the cost of debt for all firms. Nevertheless, for firms with substantial initial capital (those likely to invest even without the subsidy), this primarily translates into higher expected profits. Conversely, the effect is more pronounced for firms with limited initial capital, for whom investment would have been prohibitively costly without the subsidy program. For these firms, the government's decision to award the subsidy might trigger their investment decisions. Furthermore, this paper underscores

how, for such firms, government subsidies continue to reduce the cost of external funding in subsequent periods. Given that they receive the subsidy in the initial period, they can afford the investment and leverage the project itself as a signal of their type, thereby building a reputation. Additionally, this model considers a different source of uncertainty regarding the government signal. In Takalo and Tanayama [2010], uncertainty about signal reliability hinges on whether the government assigns the subsidy without screening the project, while in Kleer [2010], it depends on banks not knowing the rationale behind the government's subsidy allocation. In this study, the reliability of the government signal is solely contingent upon the relative screening capabilities of the government and the banks. Lastly, this paper formulates all effects in terms of their impact on the cost of debt, providing a formal framework that aids in both comprehension and empirical estimation.

1.3 Static game

As anticipated in the previous sections, I will first present the equilibrium in the static game to understand the effect of the government subsidy for R&D on firms' access to external funding. The game with continuous type is helpful to grasp the inefficiency that arises in the financial market, while for the formal analysis of the effect of the grant, I will solve the game by considering a two-type game to keep the algebra simple.

1.3.1 General setting

Let us consider an economic environment characterized by a mass equal to one of firms and two banks. Firms are of type (λ, k), where λ represents the probability of success associated with an R&D project, and k denotes the initial capital available for the project. In the event of success, the R&D project yields a return equal to R, while the firm receives no payoff in the case of failure. The total cost of the project is denoted as I. If the project cost (I) exceeds the initial capital available (k), firms must secure external funds from the market. The cost of raising external capital is determined by a function dependent on the probability of project success, denoted as $r(\lambda)$. I assume that the probabilities λ and initial capital k are independently distributed[1]. In this setting, a firm of type (λ, k) will decide to invest in the

[1] A firm can have a low level of initial resources and still have a project with a high probability of success. By the same token, a firm with a high level of k can have a project with a low probability of success.

R&D project if following condition holds:

$$\underbrace{\lambda(R - r(\lambda)(I - k))}_{\text{Expected return of investing}} \geq \underbrace{k}_{\text{Outside option}} \tag{1.1}$$

Here, the left-hand side of the inequality represents the expected return from investing in the project, taking into account the probability of success and the cost of external capital. The right-hand side represents the firm's outside option, which is to consume its initial capital endowment.

In this market, bank loans are the sole means of acquiring external funds. We consider an environment where two banks, j, engage in Bertrand competition. Each bank operates with the following profit function:

$$\Pi_j(\lambda, k) = (\lambda r(\lambda) - 1)(I - k) \tag{1.2}$$

Here, $\Pi_j(\lambda, k)$ represents the profit function of a bank in relation to a firm of type (λ, k). The bank's profit is determined by the product of the probability of success (λ), the interest rate applied to each firm ($r(\lambda)$), and the difference between the project cost (I) and the initial capital (k).

Based on the available information, banks simultaneously offer an interest rate to each firm, $r_j(\lambda) \in [1, \infty)$. Firms, upon observing the offers from banks, decide whether to accept them and, if so, from which bank, i.e. $d^j_{(\lambda,k)} \in \{0, 1\}$ where $d^j_{(\lambda,k)}$ equal to one means that a firm of type (λ, k) has taken the loan from bank j.

1.3.2 Complete Information

Consider the scenario where both banks possess perfect information regarding λ. In this setting, the game exhibits a unique equilibrium in pure strategies, which is characterized as follows:

Proposition 1: *For each (λ, k) both banks offer their break-even interest rate, $r^*(\lambda) = \frac{1}{\lambda}$. Given this equilibrium pricing, all firms with $\lambda \geq \lambda^*$ decide to invest, regardless of their initial capital k.*

Proof. See Appendix

In the equilibrium characterized by perfect information, both banks strategically tailor their interest rates to align with the precise risk profile of each firm, as determined by the parameter λ. Setting each interest rate as a function of λ ensures that firms with λ greater than or equal to $\lambda^{\star}$, where $\lambda^{\star}$ is the value of λ such that $\lambda^{\star}R = I$, find it profitable to invest, regardless of their initial capital (k). Firms decide to invest only if their expected returns, considering λ and the interest rate offered by banks, exceed their project costs (I). Consequently, only firms with projects yielding a positive net present value will choose to invest, regardless of their initial capital.

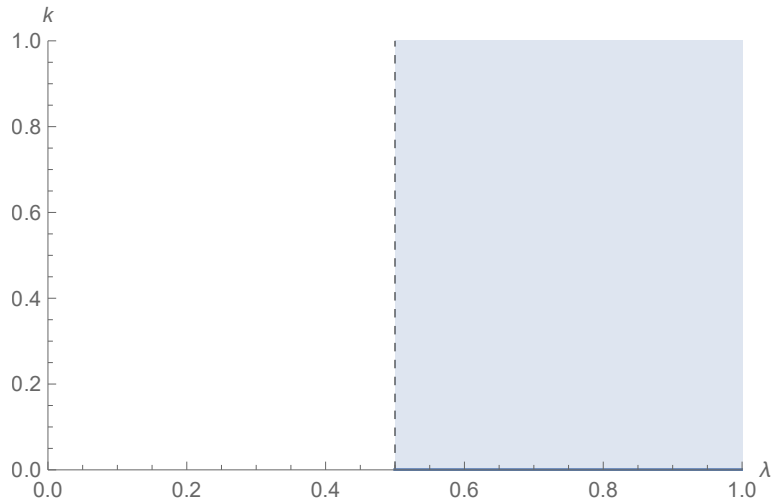


Figure 1.1 Complete Information

In this graphical illustration, the x-axis represents λ, and the y-axis depicts the initial capital available (k) to each firm. The dotted line on the graph marks the critical value λ^{*}, and the shaded light blue region represents the acceptance region. As indicated in the graph, the initial capital available does not introduce any distortion when firms are priced according to their risk profiles. In this equilibrium, all economically viable projects are developed, leading to an optimal allocation of resources.

The intuition of these results is the following. Given that banks can perfectly observe the riskiness of the firms, they will price them according to their exact probability of success. Since both banks have the same information about the firms and compete for the same sample of them, the equilibrium interest rate resembles the one of standard Bertrand competition. Both of them will offer their break-even interest rate. Upon receiving these offers, all firms with high-quality projects, independent of their k, will find it optimal to accept them since they

will make strictly positive profits. Therefore, all projects with a probability of success $\lambda \geq \lambda^{\star}$ will be developed. In this scenario, there would be no need for government intervention since all possible socially desirable projects came into being in equilibrium.

1.3.3 Incomplete Information

Let us explore an alternative scenario where banks cannnot clearly observe the quality of the projects (λ). In this information asymmetry setting, a different equilibrium emerges. Indeed, when the true λ is not observable, firms' investment decisions might depend on the level of initial capital available.

As banks cannot perfectly discern the probability of success associated with each project, the interest rates they offer become a function of the available information, denoted as $\mathcal{H}$. The quality and reliability of $\mathcal{H}$ play a pivotal role in shaping firms' investment decisions. In this setting, one of the two possible equilibria in pure strategies can emerge.

Proposition 2: *Given $\mathcal{H}$, both banks offer their equilibrium interest rate, $r^*(\mathcal{H}) = \frac{1}{E(\lambda|\mathcal{H})}$*

- *If $E(\lambda|\mathcal{H}) \geq \lambda^{\star}$, all firms with $\lambda \geq \lambda^{\star}$ will invest independently of their k but also firms with $\lambda < \lambda^*$ and $k \leq k(\mathcal{H}) = \frac{\lambda(r^*(\mathcal{H})I-R)}{\lambda r^*(\mathcal{H})-1}$ will invest.*
- *If $E(\lambda|\mathcal{H}) < \lambda^{\star}$, none of the firms with $\lambda < \lambda^{\star}$ will invest, but among the ones with $\lambda \geq \lambda^*$ only those with $k \geq k(\mathcal{H}) = \frac{\lambda(r^*(\mathcal{H})I-R)}{r^*(\mathcal{H})\lambda-1}$ will do it.*

Proof. See Appendix

Within the framework of Bertrand competition and this information structure, in equilibrium, both banks offer their break-even interest rate, denoted as $r^*(\mathcal{H}) = \frac{1}{E(\lambda|\mathcal{H})}$.

When the quality of the information is relatively high (i.e. $E(\lambda|\mathcal{H}) \geq \lambda^*$), firms with projects yielding a positive net present value (i.e. those with $\lambda \geq \lambda^*$) choose to undertake the R&D project independently of their initial capital. However, in this setting, some firms with projects with a low probability of success may also opt to invest, incentivized by the low interest rate.

Conversely, if the available information is poorly informative about the project's quality ($E(\lambda|\mathcal{H}) < \lambda^*$), banks will offer a higher interest rate to account for the increased expected risk associated with mispricing. Consequently, all firms with projects yielding a negative net

present value will choose not to invest. However, at this higher cost of debt, some firms with economically viable projects but limited capital may find it optimal not to invest. This second scenario implies a loss in terms of innovation output, as firms with ex-ante profitable R&D projects may be discouraged from undertaking them. Given this, for the subsequent analysis, we will focus exclusively on this latter case.

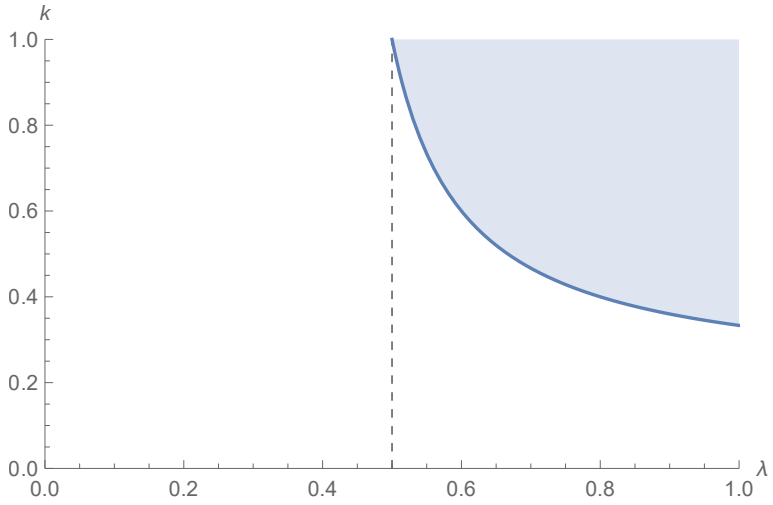


Figure 1.2 Incomplete information

Examining Figure 1.2 provides a clear understanding of the inefficiency resulting from information asymmetry. In contrast to what was observed in Figure 1.1, we can now see a slight reduction in the acceptance region, depicted by the light blue area. The loss in terms of welfare is illustrated by the area between the light blue region and the threshold value λ^*. These are the firms with limited capital but economically viable projects. Due to the higher cost of debt, they are discouraged from investing. This visualization highlights how information asymmetry has a varying impact depending on the size of the firms, as measured by their available capital. Firms with enough internal resources can absorb the higher interest rates and, as a result, the market inefficiency merely diminishes their expected profits. Conversely, more financially constrained firms cannot bear the increased cost of debt, leading them to choose not to invest in R&D projects. The size-based disparity in responses underscores the significance of firm size in shaping the consequences of information asymmetry within the market.

1.3.4 Two-types game

It is worth noting that the analysis can be summarized into the distinction between firms having projects with quality greater than $\lambda^\star$ and those without, which is equivalent to categorizing firms into those with high-quality projects (with probability of success greater or equal to $\lambda^\star$) and those with low-quality projects (with probability of success lower than λ^*) in the market. As highlighted earlier, inefficiencies in firms' investment decisions arise when firms with high-quality projects fail to signal their true type and become indistinguishable from low-quality ones.

Therefore, from now on, to further simplify the notation, let us redefine the possible λ in a binary way, i.e. firms can have a project whose probability of success is either λ_H or λ_L, where $\lambda_H > \lambda^\star > \lambda_L$. Let us define as α the share of λ_H projects in the market. Let us also consider an environment where $\mathcal{H}$ is composed only by a binary signal, $s \in \{l, h\}$. In other words, let us consider an environment where banks cannot directly observe the riskiness of the projects, but they have access to a costless but imperfect screening technology that will determine the creditworthiness of the applicants, aiming to weed out risky projects. Banks will screen all projects and, after observing the results of their tests, will simultaneously decide the interest rate they want to offer. Let us consider the following information structure for the banks' test:

$$P(h \mid \lambda_H) = 1 \qquad P(l \mid \lambda_H) = 0$$
$$P(l \mid \lambda_L) = \phi \qquad P(h \mid \lambda_L) = 1 - \phi$$

According to this assumption, when a bank observes l as a signal, it knows with certainty that it is facing a firm with a project whose probability of success is λ_L In this sense, l signals are perfectly revealing of the firm's project type. On the other hand, when the bank receives h as a signal, it knows that with some positive probability, it is making a mistake, considering as a λ_H a project whose real type is λ_L. The frequency by which these mistakes happen is determined by the accuracy of the screening technology ϕ, which is assumed to be identical across banks (i.e. symmetric screening ability). In this model, ϕ lies between zero and one i.e. $\phi \in (0, 1)$. This means that h signals are informative but not perfectly revealing of the riskiness of the projects. To allow the model to focus on pure strategy equilibrium, we assume that banks' signals are perfectly correlated. This means that for each firm, both banks observe the same signal and know that the other banks have observed the same signal. This

implies that the mass of firms assigned to h and l overlap. Although it might be a restrictive assumption, relaxing it will not change the main intuition of the results but will make it more difficult to test it empirically[2]. Let us formally introduce the timing of the game:

1. Based on $\mathcal{H}$, banks simultaneously propose the interest rate at which they are willing to lend ($r_j(\mathcal{H})$)

2. Firms observe $r_j(\mathcal{H})$ and decide whether to take the loan and from which bank

3. Banks observe the realization of the projects and returns are collected

Let us now redefine the equilibrium in this simplified setting.

Definition 1: *An equilibrium in this game is defined by a profile of strategies* $((d^*_{(\lambda,k)}), (r^*_j)_{j=1,2})$ *and a system of beliefs* ($\beta(\lambda|\mathcal{H})$) *such that:*

1. Strategies are sequentially rational given beliefs
   $\Pi_{(\lambda,k)}(d^*_{(\lambda,k)}, r_1, r_2) \geq \Pi_{(\lambda,k)}(d_{(\lambda,k)}, r_1, r_2)\ \forall(\lambda,k), d_{(\lambda,k)}$
   $\Pi_j(r^*_j, r^*_{-j}, d^*_{(\lambda,k)}; \mathcal{H}) \geq \Pi_j(r_j, r^*_{-j}, d^*_{(\lambda,k)}; \mathcal{H})\ \forall r_j$

2. *Beliefs* $\beta(\lambda|\mathcal{H})$ *are updated using Bayes rule whenever it is possible.*[3]

Proposition 3: *In this game, a unique Pure Strategy Perfect Bayesian Equilibrium (PBE) exists*[4]*. In this equilibrium, banks offer* $r^*(l) = \frac{1}{\lambda_L}$ *and* $r^*(h) = \frac{1}{E(\lambda_H|h)}$*. Firms with* λ_L *projects uniformly reject these offers regardless of their* k*. Firms with* λ_H *projects accept the offer if* $k \geq k(h) = \frac{\lambda_H(r^*(h)I-R)}{r^*(h)\lambda_H-1}$*; otherwise, they reject it.*

Proof. See Appendix

Given the aforementioned information structure, whenever a bank observes the signal l, it knows with certainty that the firm's project has a probability of success of λ_L (i.e. $P(\lambda_L|l) = 1$). Since the signals are perfectly correlated and due to Bertrand competition, both banks will optimally offer an interest rate of $\frac{1}{\lambda_L}$. Given this high interest rate, none of the firms will find it optimal to invest.

[2]As described by Broecker [1990] if banks' signals are independent there exist no pure-strategy equilibrium. Allowing the model to consider mixed-strategy equilibria does not change the main intuition of the results, but it makes it more difficult to provide clear and neat definitions of the effects.

[3]I included this part of the definition for completeness; however, it is not necessary in this case as all messages are on the equilibrium path (i.e. they occur with strictly positive probability).

[4]We are only considering the case where $E(\lambda_H|\mathcal{H}) < \lambda^*$

On the other hand, when they observe h as a signal they will offer as interest rate $\frac{1}{E(\lambda_H|h)}$, where $E(\lambda_H|h) = P(\lambda_H|h)\lambda_H + (1 - P(\lambda_H|h))\lambda_L$. Let us notice that $P(\lambda_H|h) = \frac{\alpha}{\alpha+(1-\alpha)(1-\phi)}$, which is an increasing function of ϕ and α. From this, we can clearly see that in markets with a low proportion of firms having high-quality projects or when the banks' screening ability is limited, the investment decisions of firms with less initial capital may be adversely affected.

1.3.5 Government Subsidy

The presence of this market failure provides a breeding ground for government intervention in the credit market. The government can help firms by supplying funds in the first stage of the game. Let us assume that the government itself has access to a screening technology with the same structure as one of the banks but with a different level of accuracy, defined as $\bar{\phi} \in [0, 1]$. To be more specific, for each firm, the government observes a noisy signal $g = \{h, l\}$.

$$P(h \mid \lambda_H) = 1 \qquad P(l \mid \lambda_H) = 0$$
$$P(l \mid \lambda_L) = \bar{\phi} \qquad P(h \mid \lambda_L) = 1 - \bar{\phi}$$

Therefore, like the bank, the government with some positive probability will mistakenly assign the subsidy to some λ_L. This assumption about the government screening technology simultaneously serves the purpose of maintaining some degree of symmetry in how the evaluation is conducted (both the bank and the government evaluate the same dimension of the project i.e. their probability of success) and to justify the fact that risky type applies for the subsidy program (if they could be precisely identified by the government test they would never apply).

For each firm, the government has to decide whether to give or not a subsidy based on the results of its screening test i.e. $G(g) \in \{0, S\}$, where $G(g) = S$ means that the government assigns the grant of a size S.

The government publicly commits to the following strategy:

$$G(g) = \begin{cases} S \text{ if } g = h \\ 0 \text{ otherwise} \end{cases}$$

Thus, the government will provide additional funds to all firms that it considers having a λ_H project. In this way, it can increase the number of socially desirable projects developed in equilibrium. Let us highlight that the government does not care about the interest rate that firms pay or whether banks correctly detect the risky type. Its only concern in this simplified version of the world is that the socially desirable R&D projects come into being. Furthermore, banks can observe government decision $G(g)$ and know the accuracy of its signal $\bar{\phi}$. Usually, government grants' decisions are public and observable to the market participants as the criteria adopted in the selection procedure[5].

Before moving forward with the description of the equilibrium, let us define the timing of the game:

1. Government receives g and assigns the grant
2. Based on $\mathcal{H}$, banks simultaneously propose the interest rate at which they are willingly to lend ($r_j(\mathcal{H})$)
3. Firms observe $r_j(\mathcal{H})$ and decide whether to take the loan and from which bank
4. Banks observe the realization of the projects and returns are collected

Here, the information set, denoted as $\mathcal{H}$, differs from the one described in the previous section. Specifically, for each firm, banks can observe four possible outcomes, i.e. $\mathcal{H} \in \{hh, hl, lh, ll\}$. In this scenario, banks not only observe the results of their screening tests but can also infer the government's information based on its public decision. Let us define the equilibrium of this game as follows:

[5]Another strength of the government's public signal is that it comes for free. Although this is not relevant in this context, as the banks' signals are also costless, in a more realistic setting where banks face some positive costs to acquire information about the projects, or when ϕ is not symmetric, this feature highlights its distinction from other methods of acquiring new information. I do not analyze these cases here since they do not alter the main intuition. However, allowing for asymmetric screening ability and cost signals might reveal additional channels and strengths of the public signal.

Proposition 4: *In this game, a unique PBE exists*[6]*. In this equilibrium, banks offer* $r^*(l,\cdot) = \frac{1}{\lambda_L}$ *and* $r^*(h,h) = \frac{1}{E(\lambda_H|h,h)}$*. Firms with* λ_L *projects uniformly reject these offers regardless of their* k*. Firms with* λ_H *projects accept the offer if* $k \geq k(h,h) = \frac{\lambda_H(r^*(h,h)I - R - r^*(h,h)S)}{r^*(h,h)\lambda_H - 1}$*; otherwise, they reject it*

Proof. See Appendix

Government grants ease firms' financial constraints in two ways. Firstly, government decisions reveal additional information about the project quality (certification effect). Upon observing the subsidy awards, banks can reduce the likelihood of mistakenly considering a λ_L project as a λ_H one. Consequently, this leads to a decreased interest rate, expressed as $r^*(h,h) = \frac{1}{E(\lambda_H|h,h)} \leq r^*(h) = \frac{1}{E(\lambda_H|h)}$. The strength of this effect depends on the relative values of ϕ and $\bar{\phi}$[7].

Secondly, government subsidies can help firms invest in R&D projects by providing additional resources, S (resource effect). This, coupled with the potential reduction in the interest rate, diminishes the minimum capital required to invest in the project, i.e. $k(h,h) < k(h)$. Formally, the two effects can be defined as follows:

Figure 1.3 Certification effect

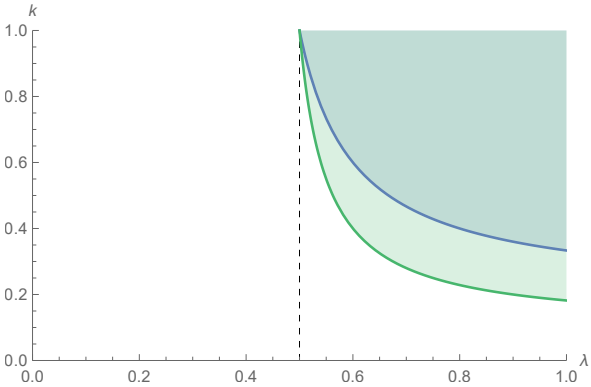
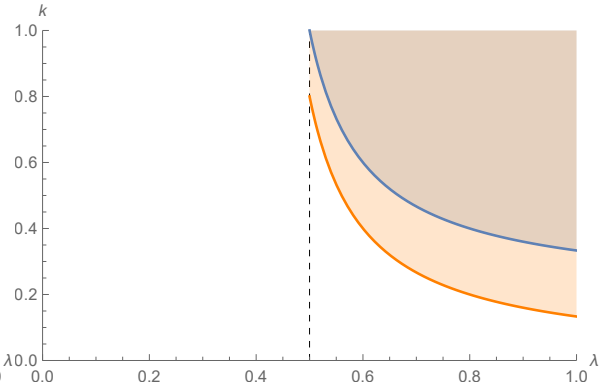


Figure 1.4 Resource effect



[6]We are only considering the case where $E(\lambda_H|\mathcal{H}) < \lambda^*$

[7]$P(\lambda_H|h,h) = \frac{\alpha}{\alpha+(1-\alpha)(1-\phi)(1-\bar{\phi})} \geq P(\lambda_H|h)$

Certification effect: *A certification effect in this setting is defined as the reduction in the interest rate induced by the disclosure of additional information about the quality of the project (i.e.* $r^*(h,h) \leq r^*(h)$*). The strength of this effect depends on the relative ability of the banks and the government to evaluate the projects.*

Resource effect: *A resource effect in this setting is defined as the reduction of the minimal capital needed to invest in the project through the provision of additional funds, the subsidy, keeping the interest rate constant (*$k(h,h) \leq k(h)$*).*

In this game, the government's decision to award subsidies to all firms it believes have high-quality projects diminishes the likelihood of the banks to mistakenly consider a low-quality project as a high-quality one. The reduction of this probability of mistakes might translate into a lower interest rate. However, if the quality of the banks' screening technology is already relatively high, receiving a subsidy does not yield a significant additional informative value. Consequently, the interest rate remains mostly unaffected. This aspect takes into account the possibility that banks may possess superior capabilities in assessing project quality compared to the government.

Since mispricing is the reason why some firms with good projects do not invest, reducing the likelihood of errors and subsequently lowering the interest rate leads to an increase in the number of firms able to afford investment. In other words, it lowers the minimum capital threshold needed to invest. However, regardless of the potential disclosure of additional information, a government subsidy introduces extra funds into the market. Consequently, even if the interest rate remains unchanged, a larger proportion of firms will opt to invest in the project. In other words, even without the certification effect, the resource effect alone will stimulate more investments among firms with less capital, providing them with additional capital at no cost.

Let us highlight that the investment decisions of firms with $k > k(h)$ are not affected by the subsidy program, even if they might benefit from the disclosure of additional information about their type and therefore pay a lower interest rate for the loan. On the other hand, for firms with $k \in [k(h,h), k(h)]$ government intervention might be a trigger, turning expensive projects into profitable ones. As one can see from the graphs, this effect could be driven both by the certification and resource effect. Moreover, if the quality of the project is informative

about the quality of the firm, over time firms with low $k \in [k(h,h), k(h)]$ can benefit from a reputation effect.

1.4 Dynamic game

As anticipated in the previous section, the informative impact of government subsidies may have a lasting effect. The rationale is that, either through the provision of additional resources or due to the positive signal about project quality leading to a subsequent reduction in interest rates, government intervention could alleviate firms' financial constraints, thereby facilitating the development of R&D projects.

However, this direct effect is not the sole one. Firms with less internal resources, for which the high project cost might be a deterrent, could enter this market and use the success of the project as a means to signal their quality to the market. In other words, when project quality is not perfectly observable but is correlated over time, firms with less capital can gain from investing in the R&D project, effectively creating a "reputation effect". This indirect effect is applicable exclusively to firms that would not have pursued the R&D project without government assistance. Firms with the financial capacity to invest even without the subsidy can establish a reputation independently while for the others the investment in the initial period may lead to significant reductions in costs during subsequent periods.

1.4.1 General setting

To formally identify both the direct and indirect effects of government aid, let us consider the following environment. As in the static case, there are two types of players in the market, firms and banks, that interact in two periods, $T \in \{1, 2\}$.

Firms are of type (λ_T, k_T), where λ_T is the probability of success associated with the firm R&D project in each period and k_T the available capital for the project. If the project succeeds it yields a return equal to R_T, if it fails the return will be equal to 0, and to be developed the project requires an initial investment defined as I_T. The initial cost of the project and the return might be different over time but the critical value of λ such that the net present value of the project is zero is assumed to be constant over time, i.e. λ^* does not change. The latter part of this assumption helps to interpret the results in light of what we have seen in the previous section. We will consider only two possible types of project, λ_L and λ_H with

the same properties described in the static game, i.e. $\lambda_H R_T > I_T > \lambda_L R_T$. [8] Across periods, the probability of success of the projects is correlated, i.e. $\rho = P(\lambda_1 = \lambda_2 | \lambda_1) > 0.5$. In this way, the model incorporates some persistence in the ability of the firms to generate successful projects. Therefore, if a firm has a high-quality project in the first period, it has a higher likelihood of having another high-quality project in the second period.

In the first period, the available capital (k_1) is randomly drawn from a uniform distribution ranging between 0 and I. In the second period, it will be equal to the profit generated from the R&D project if the firms have invested in the first period or it will be equal to the initial capital, i.e. $k_2 \in \{k_1, \Pi_{\{(\lambda,k),1\}}\}$. As in the static game, the probability of success of the project and the initial capital available are independent of each other. Therefore, observing the capital endowment of each firm is uninformative of the quality of their projects.

There are two banks, j, in the market that interact with the firms over the two periods. To keep the algebra simple, we will assume that banks are long-run players while firms are short-run. As anticipated above, all firms need to take a loan if they want to undertake the R&D project. The loan contract is exclusive (each firm can be financed only from one j), but both banks compete à la Bertrand, offering an interest rate for all firms, which will be a function of the available information about the project in each period, $r_T(\mathcal{H}_T)$.

Actions and Payoffs

In each period, banks based on $\mathcal{H}_T$ will simultaneously set the (gross) interest rate they want to offer $r_{j,T}^{(\lambda,k)} \in [1, \infty)$. Upon receiving offers, firms can decide whether and which one to accept. Let us define as $d_{(\lambda,k),T}^{j} \in \{0, 1\}$, where $d_{(\lambda,k),T}^{j}$ equal to one means that a firm with capital k and probability λ takes the loan from bank j.

Given the fact that we are in the context of exclusive contracts, we need to define a tie-breaking rule to take into account the situation where a firm is indifferent between the two offers. Specifically, if a firm gains the same profits from the offer made by the two banks, it will be randomly assigned to one of the two with equal probability. At this stage, we have all the ingredients to define the profits of the players of this game. From the firms' side in each T they compare the following payoffs:

[8] This is equivalent of saying that $\lambda_H > \lambda^* > \lambda_L$

$$\Pi_{(\lambda,k),T}(d^j_{(\lambda,k),T}, r_{j,T}) = \begin{cases} \lambda_T(R_T - r^{(\lambda,k)}_{j,T}(\mathcal{H}_T)(I_t - k_T)) \text{ if } d^j_{(\lambda,k),T} = 1 \\ k_T \qquad \text{otherwise} \end{cases}$$

The first line represents the profits that a firm with capital k and a project with the probability of success λ will make in period T if it takes the loan and develops the R&D project, while the second one represents its outside option. Since none of the firms can undertake the R&D project without the bank loans and the level of initial endowments k is project-specific, if they reject both offers they will make profits equal to their capital. Therefore, in each period firms compare the profits from investing in the R&D project, which negatively depends on the cost of debt, and the possibility of postponing this investment and remaining with their capital.

$$\underbrace{\lambda_T(R_T - r^{(\lambda,k)}_{j,T}(\mathcal{H}_T)(I_T - k_T))}_{\text{Expected return of investing}} \geq \underbrace{k_T}_{\text{Outside option}} \tag{1.3}$$

Banks' profits are described by the following equation:

$$\Pi_{j,T} = (r_{j,T}(\mathcal{H}_T)\lambda_T - 1)(I_T - k_T) \tag{1.4}$$

Given the competitive environment described above, in each period, banks based on the information available in that T can make the following expected profits for each firm of type (λ, k):

$$\Pi_{j,T}(r_{j,T}, r_{-j,T}, d^j_T; \mathcal{H}_T) =$$

$$\begin{cases} [\beta(\lambda_H \mid \mathcal{H}_T)(\lambda_H r_{j,T} - 1) + \beta(\lambda_L \mid \mathcal{H}_T)(\lambda_L r_{j,T} - 1)](I_T - k_T) \text{ if } r_{j,T} < r_{-j,T}, d^j_T = 1 \\ \frac{1}{2}[\beta(\lambda_H \mid \mathcal{H}_T)(\lambda_H r_{j,T} - 1) + \beta(\lambda_L \mid \mathcal{H}_T)(\lambda_L r_{j,T} - 1)](I_T - k_T) \text{ if } r_{j,T} = r_{-j,T}, d^j_T = 1 \\ 0 \qquad \text{otherwise} \end{cases}$$

where $\beta(\lambda \mid \mathcal{H}_T)$ are the bank's beliefs that the firm is of a given type given the information available in period T. The first line of the profit function describes the situation where bank j offers a lower interest rate with respect to its opponent and this interest rate is such that firms find it optimal to accept it. In this case, bank j will win the firm with a probability equal to one and make the expected profits. The second line, on the other hand, considers the case where both banks offer the same interest rate and this interest is such that firms find it optimal to accept it. In this case, one-half of the time j will get the firm, and one-half of the time the other bank will finance it. With the last line, we are jointly considering the event where

j offers an interest rate higher than its competitor or such that i will reject the offer. In this scenario, the bank will make zero profits.

Information structure and timing

If banks have the ability to perfectly observe the quality of the project in both periods, the equilibrium described in Section 1.3.2 will emerge. In this scenario, the interest rate will be directly influenced by the probability of project success, and under this pricing mechanism, only firms with economically viable projects will invest in both periods. When this condition is met, there is no requirement for any government subsidy, nor is there a need to discuss any reputation effect. In essence, if firms could perfectly signal their type in any period, firms with high-quality projects would invest in R&D regardless of their capital. If this is the case, $\mathcal{H}_\mathcal{T}$ will be equal to either λ_L or λ_H, and the interest rate will be a direct function of the probability of success.

On the other hand, when banks only have a noisy signal about the quality of the project, both firm behavior and the accuracy of the signal become crucial in determining the interest rate.[9]

Let us assume that banks, in both periods, have access to a costless but imperfect screening technology that provides a binary signal $s_T \in \{h, l\}$. The information structure is the same as the one described in Section 1.3.4, i.e.

$$P(h \mid \lambda_H) = 1 \qquad P(l \mid \lambda_H) = 0$$
$$P(l \mid \lambda_L) = \phi \qquad P(h \mid \lambda_L) = 1 - \phi$$

where ϕ is the accuracy of the signal. Let us redefine α as the share of firms with λ_H projects. Banks also observe $P \in \{0, 1\}$, where $P = 1$ means that the firms have successfully developed an R&D project in the previous period.[10] Let us define the timing of the game as follows:

T=1:

1. Banks screen the projects and simultaneously offer $r_1(\mathcal{H}_1)$

2. Firms observe the interest rate and decide whether to invest or not

[9] As before, we will only focus on the case where $E(\lambda_H|\mathcal{H}) < \lambda^*$.
[10] Individually both banks also observe if the debt has been repaid

3. Projects are realized and profits are collected. Firms who fail to repay the debt leave the market

T=2:

1. Banks screen the projects and simultaneously offer $r_2(\mathcal{H}_2)$

2. Firms observe the interest rate and decide whether to invest or not

In $T = 1$ the $\mathcal{H}_1 = \{s_1\}$ i.e. the only information available about the quality of the projects are the ones that arise from the screening. In $T = 2$ the information set of the banks increases since they observe both the results of their screening and the behavior of the firm in the previous period $\mathcal{H}_2 = \{s_2, P\}$.

1.4.2 Incomplete Information

If banks could perfectly observe the quality of the projects in both periods, the same equilibrium described in the static game would arise in both periods. Therefore, all firms with high-quality projects invest while the others do not. Let us now characterize the equilibrium of this game, without any government aid.

Definition 2: *An equilibrium in this game is defined by a profile of strategies* $((d^*_{(\lambda,k)}), (r^*_j)_{j=1,2})$ *and a system of beliefs* $(\beta(\lambda|\mathcal{H}_T))$ *such that:*

1. Strategies are sequentially rational given beliefs
   $\Pi_{(\lambda,k),T}(d^*_{(\lambda,k),T}, r_{1,T}, r_{2,T}) \geq \Pi_{(\lambda,k),T}(d_{(\lambda,k),T}, r_{1,T}, r_{2,T})\ \forall(\lambda,k), d_{(\lambda,k)}, T$
   $\Pi_{j,T}(r^*_{j,T}, r^*_{-j,T}, d^*_{(\lambda,k),T}; \mathcal{H}_T) \geq \Pi_{j,T}(r_{j,T}, r^*_{-j,T}, d^*_{(\lambda,k),T}; \mathcal{H}_T)\ \forall r_j, T$

2. *Beliefs* $\beta(\lambda|\mathcal{H}_T)$ *are updated using Bayes rule whenever it is possible. .*[11]

Proposition 5: *This game has a unique*[12] *PBE in pure strategies such that:*

- *In* $T = 1$ *banks offer* $r^*_1(h) = \frac{1}{E(\lambda_H|h)}$ *and* $r^*_1(l) = \frac{1}{\lambda_L}$. *All firms with* λ_L *projects reject the offer independently of their* k_1. *Firms with* λ_H *projects and* $k_1 \geq k_1(h) = \frac{\lambda_H(r^*_1(h)I_1 - R_1)}{r^*_1(h)\lambda_H - 1}$ *accept the offer while the others reject it.*

[11] As in Definition 1, all signals are on the equilibrium path and therefore updated with Bayes Rule.
[12] We are only considering the case where $E(\lambda_H|\mathcal{H}_T) < \lambda^*$

- *In $T = 2$ banks offer $r_2^*(l;) = \frac{1}{\lambda_L}$, $r_2^*(h,1) = \frac{1}{E(\lambda_H|h,1)}$ and $r_2^*(h,0) = \frac{1}{E(\lambda_H|h,0)}$. All firms with λ_L projects reject the offer independently of their k_2. All the firms with $k_1 \geq k_1(h)$ and λ_H projects invest if $k_2 \geq k_2(h,1) = \frac{\lambda_H(r_2^*(h,1)I_2 - R_2)}{r_2^*(h,1)\lambda_H - 1}$. Firms with $k_1 < k_1(h)$ and λ_H projects invest only if $k_2 \geq k_2(h,0) = \frac{\lambda_H(r_2(h,0)I_2 - R_2)}{r_2(h,0)\lambda_H - 1}$.*

Proof. See Appendix

Given the information structure described above, every time a bank observes l as a result of its screening, it knows with certainty that the firm has a low-quality project. On the other hand, when they observe h as a signal they know that with some positive probability, they are lending to a low type. Therefore $r_1^*(h) = \frac{1}{E(\lambda_H|h)}$, where $E(\lambda_H|h) = \lambda_H P(\lambda_H|h) + (1 - P(\lambda_H|h)\lambda_L$ and $P(\lambda_H|h) = \frac{\alpha}{\alpha+(1-\alpha)(1-\phi)}$. Given this interest rate, only firms with high-quality projects and $k_1 \geq k_1(h)$ invest while the others, despite having ex-ante profitable projects, decide to postpone their investment.

In the second period, banks will act in the same way with respect to all the firms for which they receive $s_2 = l$, independently of their past behaviors since this signal perfectly reveals the quality of the project. Firms that have successfully developed a R&D project in $T = 1$ and send h as a signal in the second period will be offered $r_2^*(h,1) = \frac{1}{E(\lambda_H|h,1)}$ where $E(\lambda_H|h,1) = P(\lambda_H|h,1) = \frac{\alpha\rho}{\alpha\rho+(1-\alpha)(1-\rho)(1-\phi)} \geq P(\lambda_H|h) = \frac{\alpha}{\alpha+(1-\alpha)(1-\phi)} = E(\lambda_H|h) = E(\lambda_H|h,0)$ since banks cannot infer anything for the firms that have not invested in the previous period.

This is a simple way of showing that the presence of asymmetric information might hinder firms' investment opportunities in a heterogeneous way depending on their financial means. Firms with low initial capital might be discouraged from investing in R&D projects, and their access to credit might be persistently hindered. Firms with high k can cope with the high cost of the credit, develop the projects, and build a positive reputation. In light of this, we should expect that firms with less internal resources are the ones that might benefit the most from the disclosure of additional information about the quality of their projects. This could also help them in the long run, allowing them to signal their type to the market.

1.4.3 Government Subsidy

In order to understand the long-lasting effects of the government subsidy, let us redefine and comment on how the equilibrium changes in this dynamic setting. As before, let us

assume that the government has access to a screening technology with the same characteristics described in Section 1.3.5 and that follows the same strategy. Therefore, for each project, the government receives a noisy signal about its quality and it commits to assign a subsidy to all projects it considers to be of high quality. Let us consider the scenario where there is only one subsidy program at the beginning of the game. Let us redefine the timing and the equilibrium in this setting as follows:

T=1:

1. Government receive g and assigns the grant
2. Banks screen the projects and simultaneously offer $r_1(\mathcal{H}_1)$
3. Firms observe the interest rate and decide whether to invest or not
4. Projects are realized and profits are collected. Firms who fail to repay the debt leave the market

T=2:

1. Banks screen the projects and simultaneously offer $r_2(\mathcal{H}_2)$
2. Firms observe the interest rate and decide whether to invest or not

In the first period, the information available to both banks is the result of their screening technology and the government decisions. Observing the awarding projects, banks can update their beliefs about the quality they are estimating reducing the likelihood of making a mistake. Therefore, in this setting $\mathcal{H}_1 = \{s_1, g\}$. In the second period, they observe both the result of their screening and the result of the investment in the previous period, $\mathcal{H}_2 = \{s_2, P\}$.

Proposition 6: *This game has a unique*[13] *PBE in pure strategies such that:*

- *In $T = 1$ banks offer $r_1^*(h,h) = \frac{1}{E(\lambda_H|h,h)}$ and $r_1^*(l,\cdot) = \frac{1}{\lambda_L}$. All firms with λ_L projects reject the offer independently of their k_1. Firms with λ_H projects and $k_1 \geq k_1(h,h) = \frac{\lambda_H(r_1^*(h,h)I_1 - R_1 - r^*(h,h)S)}{r_1^*(h,h)\lambda_H - 1}$ accept the offer while the others reject it.*

[13] We are only considering the case where $E(\lambda_H|\mathcal{H}_T) < \lambda^*$

- *In $T = 2$ banks offer $r_2^*(l;) = \frac{1}{\lambda_L}$, $r_2^*(h,1) = \frac{1}{E(\lambda_H|h,1)}$ and $r_2^*(h,0) = \frac{1}{E(\lambda_H|h,0)}$. All firms with λ_L projects reject the offer independently of their k_2. All the firms with $k_1 \geq k_1(h,h)$ and λ_H projects invest if $k_2 \geq k_2(h,1) = \frac{\lambda_H(r_2^*(h,1)I_2 - R_2)}{r_2^*(h,1)\lambda_H - 1}$. Firms with $k_1 < k_1(h,h)$ and λ_H projects invest only if $k_2 \geq k_2(h,0) = \frac{\lambda_H(r_2^*(h,0)I_2 - R_2)}{r_2^*(h,0)\lambda_H - 1}$*

Proof. See Appendix

The certification and resource effect work as described in the static period. Now thanks to the dynamic of the game we can see how the government subsidy might induce a persistent reduction in the cost of debt, through a reputation effect. Let us formally define the reputation effect as:

Reputation effect: *A reputation effect in this setting is defined as the reduction in the interest rate induced by the disclosure of additional information about the quality of the firm (i.e. $r_2^*(h,1) \leq r_2^*(h,0)$) for those with $k \in [k_1(h,h), k_1(h)]$. The strength of this effect depends on the persistence of the quality of the projects across periods, ρ.*

Let us compare the equilibrium outcome described in Proposition 5 with the one described in Proposition 6. In the game where there is no subsidy program, as discussed above, firms with socially desirable projects and a sufficient amount of initial resources will develop the R&D project in the first stage, paying $\frac{1}{E(\lambda_H|h)}$ as the interest rate. However, in the second stage of the game, they will be able to raise external funds at a lower cost debt, $\frac{1}{E(\lambda_H|h,1)}$, given the positive reputation effect induced by the successful development of the R&D project in the first stage. Yet, firms that could have potentially developed socially desirable projects but had a low level of initial resources in the first stage (i.e. $k_1 < k_1(h)$ are still priced at a higher interest rate, equal to $\frac{1}{E(\lambda_H|h)}$ since banks do not gain any additional information about the riskiness of their projects correctly.

When there is a government subsidy program banks can gain information in the first period by observing government decisions and increasing the precision of the results of their test. Given this, they will offer credit to the firms for which they observe h as a signal at an interest rate equal to $\frac{1}{E(\lambda_H|h,h)}$, which is less or equal to $\frac{1}{E(\lambda_H|h)}$. Indeed, the strength of the certification effect completely relies on the value of ϕ and $\bar{\phi}$. Let us consider the case where ϕ is almost equal to one i.e. banks are almost perfectly able to weed out the λ_L projects who pass their test. In this case, any additional information provided by the government will not have a significant impact, since banks are already able to screen out the project they want to finance

on their own. By the same token, if the accuracy of the screening technology of the banks is really noisy (ϕ close to zero), the certification effect induced by the subsidy will have a greater impact on the cost of debt that firms pay in the first period.

Despite the strength of the certification effect, government grants will surely provide supplementary funds to the economy (resource effect). This will allow the firms with a low level of initial endowments in the first period to invest in the R&D projects independently of the potential reduction in the cost of debt. In this sense, the subsidy program changes the incentive of firms to develop these kinds of projects making them appear ex-ante more profitable. The consequence of this is that more firms will be able to signal their true type in the second stage of the game. Therefore, firms with a low level of initial endowments (i.e. $k_1 \in [k_1(hh), k_1(h)]$) can also benefit from a reputation effect that arises from developing an R&D project, and even in the absence of a subsequent subsidy program, they can obtain external funds at better economic conditions. The reputational gain induced by the subsidy program is present only for those firms who would not have been able to invest in the R&D project otherwise. To be clear, firms with a high level of initial endowment in the first stage would pay $\frac{1}{E(\lambda_H|h,1)}$ as interest rate even without the government subsidy. On the flip side, firms with a low level of initial resources in the first stage experience a reduction in their cost of debt which drops from $\frac{1}{E(\lambda_H|h)}$ to $\frac{1}{E(\lambda_H|h,1)}$.

1.5 Conclusion

This paper analyzes the role of R&D subsidies in reducing financial constraints created by adverse selection. Financial constraints are a rationale used to justify government intervention in the form of R&D subsidies. The findings of this study provide insights into the conditions under which and the channels through which R&D subsidies could be expected to alleviate financial constraints and how this effect is heterogeneous across time and firm size. I developed a theoretical model to explain the mechanism behind the potential reduction in the cost of debt firms pay to get loans. I proved that the government subsidy programs affect firms' cost of debt under different channels. First, it could lower the cost of debt that firms pay for the project for which they are subsidized, due to a certification effect. Observing government grants' decisions, banks might gain additional information about the riskiness of the project and therefore reduce the probability of falsely considering a risky project as a safe one. This

will lower the expected probability of failure of the projects they finance, which is reflected by the fact that they can charge a lower price to their borrowers. However, the strength of the certification effect depends on the relative ability of the government and banks to correctly screen the projects. The second effect is related to the introduction of additional resources into the market (resource effect). Independently of the strength of the certification effect, the government is introducing additional resources into the market. Given this, some firms that would not have developed any R&D projects since their financial constraints were binding, can now afford to do so since the government is financing a part of it. Lastly, firms who receive the subsidy and develop the R&D project might obtain more funds at a lower cost for other future projects due to a reputation effect. Recipient firms can use the R&D project itself to build a reputation and reveal their risk type to the market. It is commonly held that SMEs face more difficulty in signaling their type to the market. Some, in the absence of the subsidy program, would not have been able to afford the development of R&D projects. Conversely, large firms have the financial means to invest in the project even without any government aid. Given this, the reputational gain that arises from the government subsidy program should be present only for the former category of firms since the latter is already able to build a reputation and reveal its riskiness to the market.

These findings underscore the considerable importance and potential impact of government subsidy programs for R&D. A well-structured and transparent allocation process has the potential to significantly reduce the cost of debt. Another critical consideration pertains to the possibility of strategically targeting subsidy programs toward areas where market asymmetry is more pronounced. This could include regions characterized by a high level of financial crimes that have potentially a higher market risk. By focusing resources on these areas, the government can effectively address information asymmetry. Furthermore, such programs could serve as a powerful incentive for small firms to participate, given that they stand to benefit the most. This, in turn, may have a positive effect on the overall volume of innovative output. However, it's worth noting that the application process for these programs can often be complex, and smaller firms may lack the organizational structure to provide all the necessary documentation. Streamlining administrative procedures and placing greater emphasis on the merit of the project through a more agile process could encourage a larger number of small firms to apply. This approach would not only broaden participation but also enhance the efficacy of the subsidy programs.

Chapter 2

R&D subsidies and firms' cost of debt: Evidence from an Italian incentive program

Joint with Elena Romito

Abstract

This paper analyzes the effect of government R&D subsidy on firms' cost of debt. When grants are assigned through an ex-ante screening procedure, external investors observing the government decision can gain information about the riskiness of a firm. Hence, recipient firms can potentially obtain external funds with better conditions due to a "certification effect". Moreover, firms with successful projects can also benefit from a "reputation effect" that will further reduce their perceived level of riskiness in the next periods. These theoretical predictions are tested on a sample of Italian firms using a Sharp-RDD. The results indicate that subsidized firms pay a lower cost of debt due to a reputation effect and that the effect is stronger for more financially constrained firms.

2.1 Introduction

Both theoretical and empirical studies agree on the leading function of R&D investments for countries' economic growth. However, despite their relevance,these investments typically fall below their socially optimal levels. Several factors might discourage firms from undertaking them, including high levels of uncertainty and risk, imperfect appropriability of returns, and inadequate financing. Given their relevance, governments worldwide try to stimulate these investments, either by directly investing in this kind of projects or by providing incentives to the private sector through direct and indirect fiscal tools such as subsidies and tax incentives. Although this phenomenon is well-recognized, there is still mixed evidence regarding the effectiveness of these measures.

With this paper, our goal is to contribute to the studies that analyze the effect of direct fiscal tools. The literature mostly surveys the impact of subsidies on two dimensions: input and output additionality. The former analyses increased investment by firms on innovative activities and whether government grants have substituted firm's own investments (crowding-out effect) or fostered them (crowding-in effect) (David, Hall, and Toole [2000], Aerts and Schmidt [2008], González and Pazó [2008]). The analysis regarding the second dimension focuses on the impact of subsidies on a firm's output, such as patents (Czarnitzki and Hussinger [2004], Bronzini and Piselli [2016]), productivity (Broekel [2015], Karhunen and Huovari [2015]), and employment (Girma, Görg, and Strobl [2007], Link and Scott [2013], Karhunen and Huovari [2015]).

We aim to deepen the analysis concerning a third dimension: behavioural additionality. We conjecture that R&D subsidies not only ease the financial burden of firms, providing immediate financial support, but also work as a market signal to reduce information asymmetry, increasing the firm's capacity to obtain external funding. This theory is particularly relevant since most R&D projects, especially the ones related to high-tech industry, tend to be too costly, and the government often cannot guarantee funds for the entire project. Therefore, the fact that R&D subsidies might operate as a market signal of the quality of the investment could reduce the information asymmetry, thus enhancing the firm's ability to obtain financing from external private investors.

The presence of asymmetric information between the lenders and the borrowers makes firms' financial a firm's financing deficit tougher increasing the cost of obtaining external

funds. Private financiers often hesitate to lend, particularly when investments heavily focus on intangible assets. This hesitation is more pronounced for firms with limited collateral value, minimal reputation, heightened bankruptcy risk, or those pursuing radical innovation strategies (Czarnitzki and Hottenrott [2011], Carpenter and Petersen [2002], Himmelberg and Petersen [1994]). At the same time, firms with low initial capital might lack sufficient internal resources to independently finance projects. The high cost of debt could hinder their ability to undertake such initiatives, resulting in a loss of innovation output. Successfully executing R&D projects can aid firms in establishing a positive reputation, thereby reducing the information gap.

With this in mind, we want to test two different channels through which government subsidies for R&D might reduce firms' cost of debt. The first is the direct effect of winning the grant ("certification effect"). External financiers, upon observing that a firm has received government funds, might update their beliefs about the quality of that project. As highlighted in the first chapter of this Thesis, the strength of this effect relies on the relative screening ability of the government compared to the banks.

In addition to the direct effect of the subsidy, we also test for the presence of an indirect effect ("reputation effect"). For firms that are more financially constrained, the cost of asymmetric information might act as a deterrent to investment. For these companies, a government subsidy might trigger new investments in R&D, allowing them to build a reputation and consequently reduce the cost of debt. External investors, observing the successful development of the project, gain additional information about the quality of the firm. In other words, firms can use the development of the R&D project itself to signal their quality to the market and experience a reduction in the cost of debt for subsequent projects.

We test our theoretical predictions on a sample of Italian firms that participate in a subsidy program implemented in 2003 in a region of northern Italy (Emilia-Romagna). In particular, we had access to the score associated with each firm through an ex-ante screening procedure and to the minimum threshold needed to obtain the subsidy. Given this, in order to estimate the effect of the policy, we compared the cost of debt paid by subsidized and unsubsidized firms close to the threshold score, using a sharp regression discontinuity design. Overall the results provide evidence in favor of the signaling effect of government subsidies. According to our results, we do not find strong evidence in favor of the certification effect. However, our findings support the hypothesis of a reputation effect for firms with initially

limited financial resources. Following project completion, companies facing more significant financial constraints experience a 1.3 percentage point reduction in their cost of debt compared to the control group.

The paper is structured as follows: a brief literature review is presented in Section 2.2, followed by the empirical strategy and results in Section 2.3, robustness checks in Section 2.4, and concluding remarks in Section 2.5.

2.2 Literature Review

The importance of government subsidies for R&D in fostering firms access to credit has been studied both from a theoretical and empirical perspective. From the theoretical side, the main papers addressing this topic are Takalo and Tanayama [2010] and Kleer [2010]. According to their results, government grants can ease firms financial constraints thanks to both a certification and resource effect. Moreover, as we have seen in the first chapter of this Thesis (R&D subsidies and firms' access to external funds: A theoretical approach), firms with a low level of initial capital might benefit from a reputation effect.

From an empirical perspective, our paper is related to the stream of literature that surveys the impact of government subsidy for R&D on firms' ability to attract external capital. Originating with the seminal paper by Lerner [2000], some authors find evidence in favor of the fact that firms who receive a grant were able to attract more venture capital (Feldman and Kelley [2006], Howell [2017]).

Others instead focus their analysis on bank loans. The first paper to study this phenomenon was Meuleman and De Maeseneire [2012]. Using a panel dataset related to a sample of 1608 Belgian firms which had applied for a subsidy program, the authors perform a conditional fixed effect logit model, finding that the long-term debt significantly increases by 5% for the recipient firms five years after the grant program. Another relevant work on the topic is the one of Wei and Zuo [2018]. The authors argue that receiving government R&D subsidies has a positive impact on innovative entrepreneurial firms by increasing their access to bank finance through a certification effect. To test this hypothesis, they analyzed a panel of 549 listed and 192 unlisted Chinese innovative entrepreneurial firms from 2009 to 2013, using a fixed effects logit panel model. The study found that obtaining government R&D subsidies had a positive certification effect on the acquisition of bank loans for all the sampled firms.Similarly,

Hottenrott, Lins, and Lutz [2018] considering a sample of German firms, find that subsidized young firms are more likely to use bank loans and to have obtained a larger share of their financing mix from banks. Li, R. P. Lee, and Wan [2020] analyze the impact of a governmental R&D subsidy program on financial constraints resulting from asymmetric information, using a FE model on a sample of high-tech firms listed on the stock exchanges in China. The results show that an increase in R&D subsidies received by a firm can boost its short-term debt financing and equity financing. However, the study did not find any evidence supporting the relationship between R&D subsidies and long-term debt financing. It is important to note that this might be due to the fact that banks in China are strictly controlled by the central government, and lending decisions are made under the government's directives, rather than relying on loan applicants' credit history and ability to repay.

Nonetheless, none of the previous studies analyze how the *cost of debt* paid by firms is affected by government subsidy programs. Indeed, the impact of the grant on external financing might not only be access to loans, but it may also affect the cost of debt. To the best of our knowledge, only Hottenrott and Demeulemeester [2017] estimated the effect of the grants on firms' cost of debt. Analyzing a panel data of Belgian firms, they show that subsidized firms, on average, face lower costs of debt and that the effect is persistent over time.

Compared to this paper, our analysis allows us to clearly disentangle the certification from the reputation effect since we can distinguish the firms' cost of debt when they receive the grant from the one they pay upon completing the R&D project. Moreover, we deepen the analysis showing how government subsidy for R&D has a heterogeneous effect on firms depending on their investment capacity. Another contribution of this study is related to the empirical strategy employed. Since treated and non-treated firms are intrinsically different, it is a central concern among scholars to adopt a strategy which correctly identifies the effect of the policy. Having access to the firms' scores we can employ a different empirical strategy (Sharp RDD) which helps us to explain the causal link between government subsidies and firms' cost of debt.

2.3 Empirical analysis

2.3.1 Insitutional setting

In order to test the theoretical predictions about the signaling effect of government grants, we will take advantage of a subsidy program implemented in a region of northern Italy (Emilia-Romagna). Emilia-Romagna is an interesting case study since it is the third-largest industrial Italian region. In 2003 the regional government launched a subsidy program[1] that works as follows: all firms that want to implement innovative projects in the region and have their operational office in the region are eligible. Another requirement was that the overall cost of the project had to be between €150,000 and €250,000. If they were awarded the grant, they could not apply for any other public subsidy program for the same project. The grant covered up to 50 percent of the costs for research projects and 25 per cent for pre-competitive development projects (for small and medium-sized firms the ceiling is 10 percentage points higher), including machinery, equipment, and software, purchase and registration of patents and licenses, employment of researchers, use of laboratories, contracts with research centers, consulting and feasibility studies, and the external costs for the creation of prototypes (Bronzini and Iachini [2014]). The program provides funds for industrial research and precompetitive development of the projects i.e. the activity necessary to convert the output of research into a plan, project, or design for the realization of new products or processes or the improvement of existing ones. Subsidized projects should be completed between 12 and 24 months after the assignment of the grant. The program allocates the subsidies in two waves: the first round of applications started in February 2004, the second in September 2004, and the evaluation process terminated in June 2004 and June 2005, respectively[2]. The grants are assigned after an ex-ante screening procedure carried out by a committee of independent experts. They analyze the projects and rate them. In particular, they evaluate the following dimensions: technological and scientific (max. 45 points); managerial (max. 20 points); financial and economic (max. 20 points); and regional impact (max. 15 points)[3]. To obtain the grant firms have to obtain a minimum score in each of these profiles

[1] Regional Program for Industrial Research, Innovation and Technological Transfer, implementing Article 4 of Regional Law 7/2002, (see: *Bollettino ufficiale della Regione* No. 64 of 14 May 2002 and *Delibera della Giunta Regionale* No. 2038 of 20 October 2003)

[2] See Bronzini and Iachini [2014]

[3] The technological and scientific dimension include: the degree of innovation of the project and the adequacy of the technical and scientific resources provided; managerial takes into account the congruence between the

and an overall score greater or equal to 75 out of 100. This assignment rule creates a clear cutoff point since only the firms with a score above 75 receive the grants. As stated above, this specific program has the important feature that the subsidy cannot cover the full cost of the project and thus, recipients still require external financing. Another advantage of this setting is the low degree of heterogeneity between applicants. Being a place-based policy we can compare firms that are more similar compared to those participating in nationwide programs, reducing the threat of unobserved heterogeneity in our sample.

2.3.2 Data and variables

We base our analysis on two sources of data. First, we use the dataset provided by the Emilia-Romagna region to retrieve information on firms' participation, assignments and scores. Second, we retrieve information on firms' financial structure from the Cerved database. Our main variable of interest is the cost of debt, computed as the the ratio between the total interests paid and the total debt. We assess the impact of the policy on credit conditions observing how this measure reacts to the grant. Furthermore, we consider a number of other variables from the Cerved dataset to compare the characteristics of treated and untreated firms. In total, taking into account both waves (2004 and 2005) the sample was composed of 749 firms (499 treated and 250 untreated). We remove firms that took part in both waves, renounced the grant or encountered a revocation of the assigned subsidy for some reasons. Moreover, we trimmed the sample according to the fifth and ninety-fifth percentile of the distribution of the cost of debt since, in this small sample, outlier values might lead to spurious discontinuities[4]. After cleaning the data we are left with 445 companies (286 treated and 159 untreated). Table 2.1 displays the descriptive statistic. The treatment group exhibits slightly higher mean values for return metrics (Roa and Roe) and value-added, but these variables also demonstrate greater variability compared to the control group. Additionally, the treatment group tends to have lower mean values for cash flow to sales and investment to sales ratios, indicating potential differences in financial performance. Conversely, the control group shows higher mean values for leverage, debt to equity ratio, total debt, and total interests while also displaying wider ranges for these variables. Notably, the cost of debt is relatively similar between both groups in terms of mean and range.

project's financial plan and objectives; financial and economic aspects are evaluated looking at past experience gained in similar projects or the level of managerial competence; the last one considers regional priorities

[4]The results of the analysis are robust even if we include them, but the magnitude increases.

Table 2.1 Descriptive statistics

	Treatment				Control			
	Mean	Std. Dev	Min	Max	Mean	Std.Dev.	Min	Max
Roa	7.35	8.232	-38.15	53,9	6.96	12.47	-57.72	49.28
Roe	10.05	36.41	-264.5	200	13.07	210.85	-843.2	3200
Cashflow/Sales	0.07	0.09	-0.959	0.45	0.11	1.24	-4.89	19.75
Investment/Sales	0.084	0.564	0	11.89	0.077	0.26	0	4
Value-Added	10399	32730	-220	416276	2816	5113	-4927	38116
Leverage	8.45	30.98	-485.7	222.1	15.44	52.41	-100.26	783.69
Debt/Equity	7.02	25.49	-401.7	207	10.88	25.68	-105.25	295.5
Debt	28061.6	95007	21	1269328	7632.59	17987.85	27	165578
Total Interests	863.9	3226.5	1	47970	239.73	588.08	1	4603
CoD	0.027	0.013	0.0018	0.057	0.027	0.014	0.0018	0.058

2.3.3 Empirical strategy

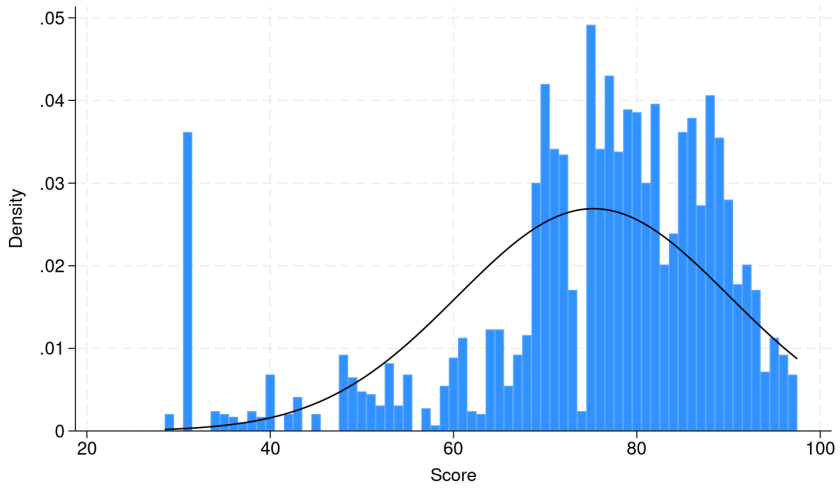
The subsidy program needs to fulfill certain requirements in order to be an effective signal. According to Spence [1979], the signal should be both credible and observable. Additionally, the assignment procedure should not be random, but based on an ex-ante screening process. The selection criteria used during the selection phase should be objective, as stated by Takalo and Tanayama [2010] and Kleer [2010]. In our sample, we assume the initial conditions are satisfied. The grant outcomes are publicly available online, and the allocation process involves the assessment of multiple factors.

From the empirical side, one of the main difficulties in assessing the causal impact of government subsidy programs is that grants are not randomly assigned. Therefore, on average, subsidized and unsubsidized firms are intrinsically different. As Jaffe [2002] points out this is due to the “selectivity" problem, which creates endogeneity in the results. In other words, a typical difficulty in assessing the effectiveness of these kinds of programs is that recipients and non-recipients might differ in terms of unobserved characteristics correlated with the outcome and hence the variable identifying recipient firms in the econometric models can be endogenous. To overcome this bias, we chose to test the potential signaling effect induced by the government subsidies on firms' ability to raise external funds using a Sharp RDD. This methodology is more suitable than other non-experimental methods to control for the endogeneity of treatment because, under some assumptions, it is possible to prove that it is equivalent to a randomized experiment. This approach depends on the continuity assumption, which requires that firms in a neighborhood just below and just above the cutoff point have

the same potential outcome. According to D. S. Lee and Lemieux [2010] this assumption holds if the treatment depends only on whether the assignment variable exceeds a known threshold and agents cannot precisely control the assignment variable. If this is the case the variation in treatment around the cutoff is randomized, as if the agents had been randomly drawn just below or just above the cutoff, and then the effect of the program is identified by the discontinuity of the outcome variable at the cutoff point.

As stated above, the main assumption needed to use an RDD approach is that there is no manipulation of the assignment variable. In order to test it, we checked the density of the assignment variable to see if there is any significant jump around the cutoff.

Figure 2.1 Density of the assignment variable



Despite a drop corresponding to score=74, the overall distribution is almost normal and thus, should not be interpreted as evidence of manipulation. It is more likely that the committee decided not to give a score just below the cutoff for practical reasons: they might have chosen to prevent discontent across the unsubsidized firms and not to leave some room for appeals against the decision[5]. Therefore this jump should not invalidate the design but rather shows that there is a limited degree of discretion in the assignment of the scores. We also perform a density discontinuity test to provide additional evidence that there is no significant jump at the cutoff[6]. From our perspective, it is possible to use RDD in this setting since firms cannot precisely control their score. Therefore we estimated the following model. For each firm $i = 1, ..., I$ let us define Tr_i as an indicator variable equal to 1 if the firm was awarded

[5]See Bronzini and Piselli [2016] and Bronzini and Iachini [2014]
[6]See Appendix

the subsidy (i.e. it is treated) and 0 otherwise. The value of Tr_i depends on whether our assignment (or forcing or running) variable is above some threshold. In this specific case, the assignment variable corresponds to the score obtained by each firm and the assignment rule is $Tr_i = \mathbb{1}(Score_i \geq c)$ where $Score_i$ is the score obtained by firm i and $c = 75$. If the continuity assumption holds, it is possible to estimate the average (local) causal effect, which is identified by the parameter β in the following equation.

$$Y_i = \alpha + \beta Tr_i + f(X_i) + f(X_i) \times Tr_i + \epsilon_i \tag{2.1}$$

where Y_i is the outcome variable (i.e. the cost of debt), Tr_i is a dummy variable equal to one if firm i receives the subsidy, $X_i = Score_i - 75$ is the running variable centered at the cutoff point, and $f(X_i)$ is the generic functional form of the assignment variable. If the model is correctly specified, the OLS estimate of β will provide an unbiased estimate of the local average causal effect around the cutoff of the grant program in easing firms' funding gap.

According to the theoretical prediction developed in the first chapter of this Thesis, subsidized firms should experience a reduction in their cost of debt upon receiving a grant, due to the certification effect. This is defined as the difference between the interest rate that firms would have paid without the grant and the one they pay after receiving the grant (i.e $r_1^*(h,h) \leq r_1^*(h)$). Furthermore, after completing the project, firms with low investment capacity should experience a subsequent reduction in their cost of debt, defined as the reputation effect. Formally, this is the difference between the interest rate that firms with good projects and low capital would have paid if they didn't develop the project in the first period and the one they pay after successfully completing the R&D project (i.e $r^*(h,1) \leq r^*(h,0)$)[7]. In order to identify these effects, we first estimate the RDD in the year firms received the subsidy (i.e. 2004 for firms who participated in the first wave and 2005 for the second) to look for evidence in favor of the certification effect. Second, we reproduced the analysis in the year firms completed the project financed through the grant (2006 and 2007 respectively) to see whether there is a reputation effect. We first start considering the entire sample and the we split it according to the capital available to invest. In principle, the reputation effect should be present only for firms with limited investment capacity (i.e. $k_1 \in [k_1(hh), k_1(h)]$)[8]. As we cannot precisely observe this type of firm, we use the cashflow to sales ratio as a proxy to

[7] See *R&D subsidies and firms' access to external funds: A theoretical approach*

[8] See *R&D subsidies and firms' access to external funds: A theoretical approach*.

identify firms with less investment capacity. According to the literature, this measure is a good indicator of firms' capital availability and a reliable predictor of their investment capacity (Gilchrist and Himmelberg [1995], Bushman, Smith, and Zhang [2011]). This relationship is particularly significant for R&D investments, which explains how financially constrained firms can only rely on their existing capital to invest, and their investment decisions are closely linked to this measure (Bloch [2005], Aggarwal and Zong [2006]).

2.3.4 Baseline results

This section briefly discusses the baseline results of the analysis. According to D. S. Lee and Lemieux [2010] the choice of both the optimal bandwidth and the functional form presents some trade-offs. In particular, using larger bandwidths allows the researcher to find more precise estimates since more observations are counted in the regression. On the other hand, it is more unlikely that a linear specification of the model can hold. If the underlying conditional expectation is not linear, this specification will lose power over a larger bandwidth while it could still be a good approximation of the data close to the cutoff. However, in the non-linear case, larger bandwidths introduce more bias in the estimated coefficients. Therefore there is a clear trade-off between efficiency and bias induced by the choice of the "right" bandwidth.
Concerning the choice of the right polynomial order, a useful rule of thumb can be the one related to the dimension of the bandwidth: larger bandwidths call for a higher polynomials degree while with small bandwidths it is preferable to use lower order. Gelman and Imbens [2019] point out that it is always better to pick polynomials with a degree less than or equal to two. Higher polynomials might lead to results highly sensitive to the choice of the degree, misleading confidence interval, and noisy estimates. Therefore, we estimate our baseline model with both a linear and quadratic polynomial. As with regard to the bandwidth choice, we consider three different intervals: 69-78; 68-79, and 67-80. We preferred asymmetric bandwidths on the two sides of the cutoff to try to balance the number of treated and untreated firms.[9]
As shown in Table 2.2, the analysis of the baseline model provides supporting evidence in favor of the theoretical predictions. According to both the linear and quadratic specifications, the reputation effect is stronger than the certification effect and its magnitude decrease with

[9]Nevertheless, the results do not show any significant difference if we apply the same bandwidth and the two sides of the cutoff (i.e. if we consider the intervals 69-81, 67-83, 65-85). See Bronzini and Iachini [2014] for further deepening on this choice.

Figure 2.2 Baseline results

(a) *Certification effect* (b) *Reputation effect*

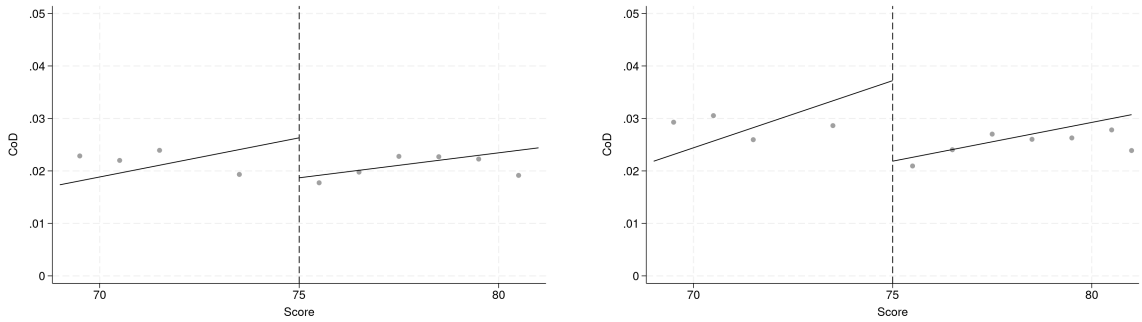


Table 2.2 Baseline results

	Certification effect			*Reputation effect*		
Bandwidth:	b^*-1	b^*	b^*+1	b^*-1	b^*	b^*+1
p(1)	-0.009*	-0.006	-0.005	-0.016**	-0.013**	-0.012**
	(0.005)	(0.004)	(0.004)	(0.007)	(0.006)	(0.005)
p(2)	-0.038***	-0.027***	-0.020***	-0.053***	-0.041**	-0.030**
	(0.010)	(0.008)	(0.007)	(0.022)	(0.017)	(0.014)

Notes: The first row shows the coefficient of the linear estimation while the second one represents the estimates of the quadratic polynomial. Standard errors are presented in parentheses. Significance level: * p<0.1; ** p<0.05; *** p<0.01. Results are estimated with a local linear regression, robust standard errors and triangular kernel. The smaller bandwidth, b^*-1, (69-78) contains $\approx$ 25% of the sample; the optimal bandwidth, b^* (68-79) contains $\approx$ 30% of the sample; the larger bandwidth b^*+1 (67-80) $\approx$ 35% of the sample.

larger bandwidths. However given the small size of our sample, we rather focus on relatively small bandwidth (b^*) and the linear approximation. Indeed, with relatively few observation the quadratic specification together with the presence of outliers might lead to misleading high coefficients.

In the first period, when only the certification effect is in place, we did not observe any significant reduction in the cost of debt paid by subsidized firms.[10] Nevertheless, once the project is completed and banks can directly observe the firms' types the difference between the cost of debt paid by subsidized and unsubsidized sharply increaseas. Indeed, depending on the specification considered, their cost of debt is on average 1.3 percentage points lower. The effect is stronger for firms closer to the cutoff since they are the ones for which banks are more likely to make a mistake.

[10]Only the results associated with the smaller bandwidth is significant at the 10% level. It might be argued that these firms are the ones that appear more alike from an ex-ante perspective and therefore might benefit the most from the disclosure of additional information about their type. These firms pay a cost of debt 0.9 percentage points lower compared to the control group.

2.3.5 Results by available capital

According to with the theoretical predictions, the effect should be heterogeneous depending on the available capital to invest in the R&D project. Firms with high capital ($High\ K$) would have developed the R&D project in any case, with or without the R&D project. Therefore for this group of firms, we do not expect to find any significant difference in the cost of debt they pay in the second period. On the flip side, for firms with low capital ($Low\ K$) government subsidy might trigger the investment in the first period, thanks to both the certification and resource effect, and thus allow firms with a low level of initial resources to build a reputation and pay a lower cost of debt in the second period. Therefore, in the first period firms might benefit from the certification effect independently of their k, while in the second firms with less financial means should experience a more significant reduction in their cost of debt. As discussed in the previous section, in order to test this line of reasoning, we split the sample between firms with $High$ and $Low\ k$ and we define as $Low\ k$ all those firms with a cash-flow to sales ratio below the median.[11] We then re-estimate Equation 2.1 first for firms with a cash-flow to sales ratio below the median and then for those above it. We also consider the combination of asymmetric bandwidths that allows us to (mostly) balance the observations on both sides of the cutoff. The sample size is significantly smaller and represents a different percentage of the sample considered [12]

Before describing the results of this analysis let us briefly comment on the summary statistics of these two groups. As shown in Table 2.3, $Low\ k$ firms pay on average a higher cost of debt equal to 2.8% compared to $High\ k$ firms (2.6%). Moreover, the average amount of debt they have on their balance sheet is highly different in terms of magnitude and also the financial leverage. $High\ k$ take more loans but this represents a smaller percentage of their total assets. On the flip side, $Low\ k$ firms mostly rely on banks loans to survive.

The results of this analysis provide additional evidence in support of the theoretical predictions. As one can see from both the graphical and formal analysis (i.e. Table 2.4 and Figures 2.3), the jump in the cost of debt is statistically significant only for firms with limited investment capacity in the second period and the magnitude of the effect is similar to the one

[11] We also estimate the model taking the number of employees as a measure of "size". As stated into the EU recommendation 2003/361, we consider small firms the ones with less than 50 employees. The results are consistent, yet the sample size sharply decreases due to the high number of missing values associated to this variable.

[12] The sample is composed by 220 $Low\ k$ firms (137 treated and 83 untreated) and 225 $High\ k$ firms (149 treated and 76 untreated).

Table 2.3 Descriptive statistics, by k

	Treatment				Control			
	Mean	Std. Dev	Min	Max	Mean	Std.Dev.	Min	Max
Low k								
Roa	3.944	5.951	-38.15	27	2.358	12.044	-67.72	45.23
Roe	-1.674	41.238	-264.55	200	-22.515	112.427	-843.24	151.51
Investment/Sales	0.104	0.822	0	11.892	0.044	0.076	0	0.435
Value-Added	4769.852	15030.01	-220	196252	1790.348	3823.468	-4927	35603
Leverage	11.587	45.059	-485.69	222.1	17.534	25.513	-100.26	120.54
Debt/Equity	9.86	35.91	-401.6	207	16.3	33.7	-105.25	295.5
Debt	18874.98	67994.71	33	651032	6641.58	14685.01	27	133623
Total Interests	616.607	2629.243	1	34039	227.478	542.538	1	4603
CoD	0.028	0.014	0.0018	0.057	0.028	0.014	0.0018	0.058
High k								
Roa	10.212	8.788	-21.36	53.9	11.515	11.185	-28.5	49.28
Roe	19.749	28.517	-105.7	176.19	47.647	270.632	-52.2	3200
Investment/Sales	0.068	0.142	0	1.264	0.111	0.362	0	4
Value-Added	15139.54	41679	33	416276	3827.464	5968.091	-242	38116
Leverage	5.781	5.964	1.37	48.83	13.373	69.452	1.27	783.69
Debt/Equity	4.63	10.1	0.14	145.4	5.51	11.5	0.15	127
Debt	35795.88	112395.6	21	1269328	8609.436	20744.03	67	165578
Total Interests	1072.136	3646.365	1	47970	251.814	631.496	1	4262
CoD	0.026	0.013	0.003	0.057	0.025	0.014	0.002	0.056

of the all sample. In this case, treated firms pay a cost of debt that on average is 1.3 percentage points lower compared to the control group. There is no significant evidence at all of any reputational gain for firms with $High\ k$. On the other hand, with respect to the effect in the first period, we can see that there are no significant discontinuities.

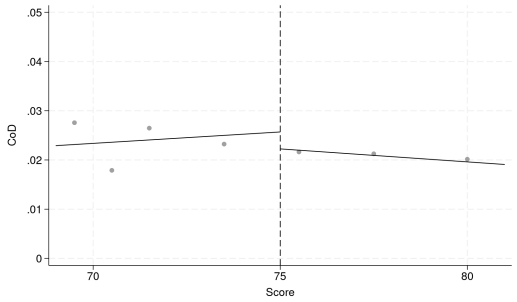
Table 2.4 Results by k

	Certification effect			*Reputation effect*		
Bandwidth:	$b^* - 1$	b^*	$b^* + 1$	$b^* - 1$	b^*	$b^* + 1$
Low k	-0.007	-0.006	-0.007	-0.012**	-0.013**	-0.013***
	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)
High k	-0.009	-0.009	-0.006	-0.011	-0.010	-0.009
	(0.006)	(0.006)	(0.006)	(0.008)	(0.008)	(0.008)

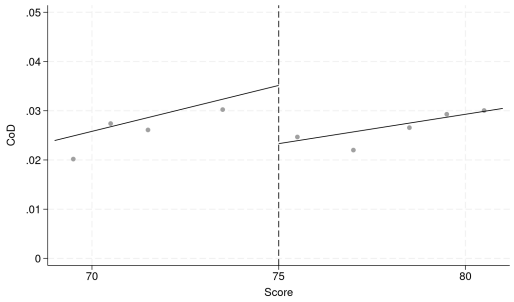
Notes: Standard errors are presented in parentheses. Significance level: * p<0.1; ** p<0.05; *** p<0.01. Results are estimated with a local linear regression, robust standard errors and triangular kernel. The smaller bandwidth, $b^* - 1$, (68-79) contains $\approx$ 30% of the sample; the optimal bandwidth, b^* (67-80) contains $\approx$ 35% of the sample; the larger bandwidth $b^* + 1$ (66-81) $\approx$ 40% of the sample.

Figure 2.3 Results by k

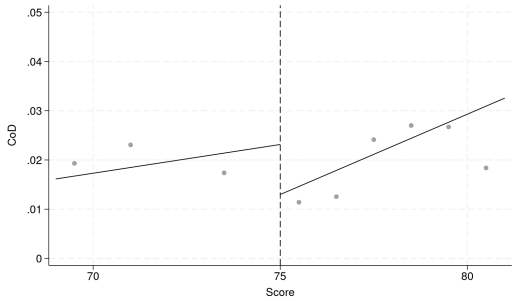
(a) $Low\ k$, *Certification effect*



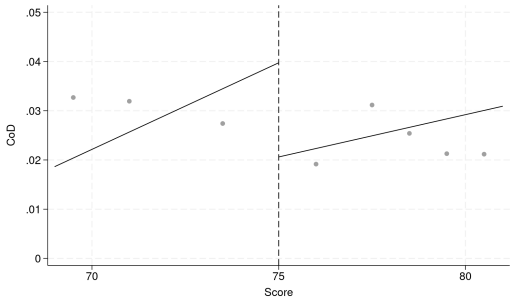
(b) $Low\ k$, *Reputation effect*



(c) $High\ k$, *Certification effect*



(d) $High\ k$, *Reputation effect*



According to these results, the effect of government subsidy for R&D on firms' cost of financing is present only in the form of reputation effect for those firms that would not have undertaken the project otherwise. The absence of a strong certification effect might be due to a relatively low screening ability of the government compared to the banks. However, in this setting the lack of strong evidence in favor of the certification might directly directly stem from technical factors associated with the outcome variable. Indeed, firms in both waves grant the subsidy in June, whereas the cost of debt represents a yearly average encompassing interest expenditure and total debt cost. Consequently, if the subsidy-induced reduction in the cost of debt within the latter six months isn't large enough, it might be mechanically offset by the initial six months without the subsidy.

2.4 Robustness checks

In the section we performed some test to provide additional validity of the results of our analysis.

Firstly, if the assumption that agents do not have precise control over the assignment variable holds, then there should be no discontinuities in variables that are determined prior to

the assignment. Therefore, it is possible to test the validity of this design by verifying whether differences in treated and control firms' observable characteristics become negligible close to the cutoff point. In light of this, we replicate the same analysis taking as dependent variables both the outcome variables and the other relevant covariates in the period before the subsidy (2003 for the firms who participated in the first round and 2004 for the others). The results presented in Table 2.5 show that overall neither the outcome variable or the other covariates present significant discontinuities before the treatment, pointing out that the effect we observe in the main analysis is not driven by pre-detemined significant differences.

Table 2.5 Pre-treatment discontinuities

	All			*Low k*			*High k*		
Bandwidth:	b^*-1	b^*	b^*+1	b^*-1	b^*	b^*+1	b^*-1	b^*	b^*+1
Covariates									
Roa	-4.86	-4.55	-4.06	-3.47	-2.37	-1.42	-4.77	-4.56	-4.89
	(3.30)	(2.91)	(2.71)	(3.09)	(2.65)	(2.28)	(4.46)	(4.37)	(4.33)
Roe	-11.3	-13.7	-13.1	-15.3	-10.6	-6.61	-6.89	-6.64	-9.32
	(15.1)	(13.6)	(12.7)	(15)	(14.4)	(13.13)	(19.3)	(18.8)	(17.9)
Int inv/sales	-0.03	-0.05	-0.07	0.07	-0.009	-0.017	-0.11	-0.11	-0.10
	(0.06)	(0.06)	(0.06)	(0.02)	(0.02)	(0.03)	(0.12)	(0.12)	(0.12)
Cashflow/sales	0.06	-0.04	-0.06	-0.04	-0.03	-0.02	-0.02	-0.02	-0.03
	(0.19)	(0.15)	(0.12)	(0.03)	(0.02)	(0.02)	(0.27)	(0.25)	(0.24)
Value-added	495	1305	1563	-865	-926	-944	3960	4223	5074
	(1567)	(1492)	(1514)	(2168)	(2003)	(1864)	(2450)	(2623)	(2850)
Leverage	1.13	0.59	-0.44	-0.16	0.63	-0.11	-2.41	-2.94	5.59
	(3.79)	(3.19)	(3.12)	(5.23)	(4.72)	(4.22)	(2.92)	(3.02)	(9.49)
Debt/Equity	0.28	-0.63	-0.82	-2.29	-1.27	-1.43	-0.66	-1.24	-1.86
	(3.73)	(3.11)	(3.04)	(5.18)	(4.77)	(4.35)	(2.98)	(2.98)	(3.01)
CoD	-0.007	-0.006	-0.006	-0.007	-0.003	-0.002	-0.002	-0.011	-0.011
	(0.006)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)	(0.008)	(0.007)	(0.007)

Notes: Standard errors are presented in parentheses. Significance level: * p<0.1; ** p<0.05; *** p<0.01. Results are estimated with a local linear regression, robust standard errors and triangular kernel. For the main analysis the smaller bandwidth, b^*-1, (69-78) contains $\approx$ 25% of the sample; the optimal bandwidth, b^* (68-79) contains $\approx$ 30% of the sample; the larger bandwidth b^*+1 (67-80) $\approx$ 35% of the sample. For the analysis related to the sample splitted by the median of the cash-flow to sales ratio the smaller bandwidth, b^*-1, (68-79) contains $\approx$ 30% of the sample; the optimal bandwidth, b^* (67-80) contains $\approx$ 35% of the sample; the larger bandwidth b^*+1 (66-81) $\approx$ 40% of the sample.

Furthermore, to simultaneously test the validity of the empirical analysis and provide further evidence in favor of the reputation and certification effect we tested whether the significant reduction in the cost of debt paid by firms can be caused by other external factors. Therefore we run the same regression specifications on the other relevant covariates to look over any other significant jumps.

As the results of Table 2.6 show, almost all the covariates are continuous after the treatment. Even if there are few significant jumps for some of them, it does not look like there is a clear pattern. In particular, none of the financial variables considered present any significant

Table 2.6 Post-treatment

	$T=1$			$T=2$		
Bandwidth:	b^*-1	b^*	b^*+1	b^*-1	b^*	b^*+1
All						
Roa	-5.34	-5.91*	-5.39*	-3.44	-3.15	-2.37
	(3.39)	(3.25)	(3.10)	(2.26)	(2.14)	(2.03)
Roe	-41.62	-38.64	-34.36	-40.73	-32.73	-23.86
	(34.78)	(31.52)	(28.58)	(26.96)	(22.48)	(17.58)
Inv tot/sales	0-029	0.006	-0.12	0.55	0.10	-0.13
	(0.10)	(0.09)	(0.08)	(0.49)	(0.18)	(0.26)
Value-added	1211.1	1676.1	1845.5	-1876.1	-1061.5	-603.3
	(1722.8)	(1577.3)	(1574.6)	(2355)	(2491)	(2511)
Leverage	1.31	1.16	0.68	-1.36	-1.27	-2.91
	(4.09)	(3.55)	(3.22)	(9.11)	(7.69)	(6.78)
Debt/Equity	2.58	2.09	1.39	-10.2	-5.06	-2.49
	(5.19)	(4.16)	(3.55)	(11.3)	(8.92)	(8.06)
Low k						
Roa	-3.11	-3.05	-2.28	-5.03	-5.18*	-3.28*
	(4.98)	(4.63)	(4.31)	(2.65)	(2.65)	(2.36)
Roe	-46.71	-43.51	-34.67	-38.3	-37.4	-17.3
	(50.79)	(46.29)	(42.68)	(29.1)	(29.2)	(19.7)
Int inv/sales	0.011	0.018	-0.0006	-0.54	-0.55	-0.82
	(0.028)	(0.028)	(0.025)	(0.593)	(0.594)	(0.844)
Value-added	632.2	701.9	513.3	-2129.5	-1891.9	-1487.9
	(901.9)	(893.6)	(1021.2)	(1558.7)	(1564.8)	(1518.9)
Leverage	-0.271	-0.699	-0.666	-6.12	-8.39	-8.41
	(4.88)	(4.74)	(4.09)	(14.27)	(14.14)	(12.21)
Debt/Equity	3.81	3.52	2.23	-3.35	-4.68	-0.66
	(5.95)	(5.87)	(4.34)	(17.71)	(17.62)	(16.39)
High k						
Roa	-4.50	-5.17*	-4.66	1.17	1.37	1.57
	(2.95)	(3.07)	(3.12)	(2.33)	(2.48)	(2.51)
Roe	-6.87	-8.02	-7.99	-0.11	-1.88	-3.65
	(10.74)	(11.29)	(11.43)	(16.43)	(17.11)	(17.03)
Int inv/sales	0.025	0.021	0.013	0.091	0.095	0.078
	(0.197)	(0.196)	(0.176)	(0.31)	(0.31)	(0.28)
Value-added	3929.7	4129.3	4600.1	665.95	957.4	1343
	(3035.9)	(3060.1)	(3060.9)	(4332.5)	(4364.7)	(4398.1)
Leverage	-0.25	-0.24	-0.55	-0.09	-0.11	0.25
	(3.016)	(3.046)	(2.912)	(2.96)	(2.95)	(2.69)
Debt/Equity	-2.87	-2.93	-2.92	-0.48	-0.45	-0.29
	(2.50)	(2.52)	(2.49)	(2.03)	(2.01)	(1.94)

Notes: Standard errors are presented in parenthesis. Significance level: * p<0.1; ** p<0.05; *** p<0.01. Results are estimated with a local linear regression, robust standard errors and triangular kernel. $T = 1$ is the year when firms receive the grant, while $T = 2$ is the year after they have completed the subsidized project. For the main analysis the smaller bandwidth, $b^* - 1$, (69-78) contains $\approx$ 25% of the sample; the optimal bandwidth, b^* (68-79) contains $\approx$ 30% of the sample; the larger bandwidth $b^* + 1$ (67-80) $\approx$ 35% of the sample. For the analysis related to the sample splitted by the median of the cash-flow to sales ratio the smaller bandwidth, $b^* - 1$, (68-79) contains $\approx$ 30% of the sample; the optimal bandwidth, b^* (67-80) contains $\approx$ 35% of the sample; the larger bandwidth $b^* + 1$ (66-81) $\approx$ 40% of the sample.

discontinuity highlighting how the reduction in the cost of debt is driven by an informational gain and not by a structural change in the firms' financial position. This validates an argument favouring the certification and reputation effect. Subsidized and unsubsidized firms appear identical to the eyes of external investors with respect to their observable characteristics. Any reduction in the cost of debt cannot derive from an increase in the level of productivity or investment.

Additionally, we performed a placebo test considering two different cutoff points, 65 and 85. If the discontinuity in the cost of debt depend on the subsidy program we should not find any significant difference between the treatment and control group at different scores. Table 2.7 presents the estimates obtaining with the main specification and the two fake cutoffs. The lack of significant jump provides further evidence on the validity of the main analysis.

Table 2.7 Placebo cutoff

	Certification effect			*Reputation effect*		
	All	$Low\ k$	$High\ k$	All	$Low\ k$	$High\ k$
c(65)						
	0.03	0.00048	-0.036	0.005	0.008	0.0008
	(0.005)	(0.006)	(0.005)	(0.008)	(0.012)	(0.011)
c(85)						
	0.003	0.00068	-0.002	-2.3	0.007	-0.009
	(0.004)	(0.006)	(0.005)	(0.004)	(0.005)	(0.006)

Notes: Standard errors are presented in parentheses. Significance level: * p<0.1; ** p<0.05; *** p<0.01.Results are estimated with a local linear regression and triangular kernel. All coefficients refer to the optimal bandwidth.

Lastly, we replicate the analysis employing an alternate kernel, incorporating fixed effects and clustering the standard errors with respect to the score. The results of Table 2.8 reveal consistent findings across all specification. All coefficients have a similar magnitude and significance of the ones of the main specification.

Table 2.8 Different specifications

	Certification effect			*Reputation effect*		
	All	$Low\ k$	$High\ k$	All	$Low\ k$	$High\ k$
Uniform Kernel	-0.004	- 0.008	-0.006	-0.010*	-0.014**	-0.007
	(0.005)	(0.006)	(0.005)	(0.006)	(0.007)	(0.008)
Fixed Effects	-0.006	-0.006	-0.009	-0.011**	-0.012**	-0.013
	(0.004)	(0.007)	(0.006)	(0.006)	(0.006)	(0.008)
FE and clusterd se	-0.006	-0.006	-0.009	-0.011*	-0.012***	-0.012
	(0.008)	(0.007)	(0.009)	(0.007)	(0.003)	(0.010)

Notes: The first row show the estimates of the main model using the uniform kernel. The second the estimates of the main model controlling for competition fixed effects. The third row presents the results of the analysis with competition fixed effects and standard errors clustered by score. Standard errors are presented in parentheses. Significance level: * p<0.1; ** p<0.05; *** p<0.01. Results are estimated with a local linear regression and all the coefficients refer to the optimal bandwidth.

2.5 Conclusion

This paper analyzes the role of R&D subsidies in reducing financial constraints created by adverse selection. The presence of binding financial constraints might prevent a firm to take some investment opportunities, like R&D projects, if the initial cost of the project is too high. This paper contributes to the literature on the effectiveness of government subsidy programs, highlighting how government grants can ease firms' financial constraints helping them to obtain more funds at a lower cost.

According to the empirical results, government subsidies for R&D decrease firms' cost of debt, and this effect is heterogeneous across firms with different capital availability. The empirical evidence confirms the theoretical prediction that the reputation effect is present only for firms that are ex-ante more financially constrained. However, we did not find strong evidence in favor of the certification effect. As pointed out before, the strength of this effect depends on how much the government is better informed than the banks with respect to the quality of the project. Therefore, it might be the case that in different economic contexts, where banks face a more severe adverse selection, government decisions might have a greater impact. Another possible explanation for the reduced observability of the certification effect in this setting can derive from the structure of the data. As a proxy of the cost of debt that a firm pays to finance the project for which it is subsidized, we consider the cost of debt paid by the firm in the year it receives the grant. This yearly measure also takes into account the cost of different loans that the firm took before being awarded with the subsidy. Hence, it

might also be that if one could look at the specific cost of debt associated with the project there is a stronger and more significant effect.

In light of the preceding discussion, we can conclude that firms with less investment capacity are the ones that benefit the most from receiving a subsidy for R&D since it provides them with the ability to access the credit market and build a reputation for the future. This result is also consistent with the previous empirical findings, which proved that over time firms increase the number of bank loans on their balance sheets. Therefore, government subsidies for R&D do not only immediately reduce firms' financial constraints but it also increases their ability to attract external funds, given their "newly gained" reputation.

Chapter 3

The Ripple Effect: Children's Job Insecurity and Parents' Labor and Consumption Choices

Joint with Tuna Dökmeci

Abstract

This paper studies the effect of young adults' job insecurity on the consumption and labor supply decisions of their parents. Using data from the Italian Survey on Household Income and Wealth (SHIW), we causally estimate this effect by exploiting a labor market reform ("Fornero reform") that substantially reduced firing costs for workers in firms with more than 15 employees. According to our findings, working parents of treated adult children reduced their consumption by €2,453 per year. This effect is driven by the drop in durable consumption, which yearly decreases by €1,600. Even if we do not find any substantial and significant effect on the intensive and extensive margin of labor, we observe that the impact on consumption is stronger for retired parents who are constrained in their ability to adjust their labor supply and who also reduce their non-durable expenditures.

3.1 Introduction

Youth unemployment is a main source of heterogeneity in European countries unemployment, being very high in Southern European economies (e.g. Italy and Spain) while below two-digit levels in Northern countries like for instance Germany and Netherlands (Boeri and Jimeno [2015]). Furthermore, since older workers are usually more protected than younger workers and experience on average lower unemployment rate, the pervasiveness of labor market flexibility makes it more difficult for younger people to secure stable employment trajectories (O'Reilly et al. [2015]).

During the last two decades Italy has faced various economic crises that have had a severe impact on its economy, leading to a rise in the unemployment rate (Adda and Triggari [2016]). However, the effect of these recessions has not been the same for all age groups. The younger generation has been hit harder, with higher unemployment rates, lower wages, financial and career insecurity, and weaker workplace protections (Marino and Nunziata [2017]). In a similar scenario, this paper delves into the often overlooked repercussions of these uncertainties on the financial decisions of parents. This intergenerational economic dynamic highlights how altruistic parents adapt their consumption and labor decisions in response to fluctuations in their adult children's job security.

Several papers study how variation in people job insecurity directly affect their life. For example, Fogli [2004] and Becker, Bentolila, Fernandes, and Ichino [2010] highlight how young adults delays emancipation in response to an increase in job's insecurity while Ranjan [1999] and De Paola, Scoppa, et al. [2020] find a negative effect on fertility choices. Other studies provide evidence that high job insecurity hampers access to credit (Mistrulli, Oliviero, Rotondi, and Zazzaro [2023]), increase the probability of getting married (Weiss [1997], Hess [2004]) and raises saving (He, Hui and Huang, Feng and Liu, Zheng and Zhu, Dongming [2018], Clark, D'Ambrosio, and Lepinteur [2022]). At the same time, especially in countries with strong family ties, the potential effect on the other members of the family cannot be ignored. Previous studies, including J. G. Altonji, Hayashi, and L. J. Kotlikoff [1997], Hayashi, J. Altonji, and L. Kotlikoff [1996] and Choi, McGarry, and Schoeni [2016], have examined the insurance function of families. They found evidence that extended family income affects one's consumption.

This research paper presents new evidence that parents save money to provide insurance for their children against income risks. By extending the theory of saving across generations, we focus on inter-vivos transfer and precautionary saving for altruistic motives (Lugilde, Bande, and Riveiro [2017]). We show that in the face of uncertainty regarding their children's income, altruistic parents adjust their current consumption to build precautionary savings that can safeguard against potential negative income outcomes of their children. Moreover, we further delve into the analysis underlining how households save in response to an increase in children's job insecurity. Specifically, we analyze how they shift their portfolio towards more liquid assets to prepare for a potential future income shock. We consider as a foreseeable income shock an increase in job insecurity faced by children. In contrast to unemployment, job insecurity is characterized as a forward-looking concept encompassing both the real and perceived risks of job loss. Following Hellgren, Sverke, and Isaksson (1999), we here consider that job insecurity refers to the fear of a worker about job loss.

In our study, we utilize the 2012 Fornero labor market reform in Italy as a quasi-natural experiment to investigate the impact of children's job insecurity on parents' consumption and savings. We employ a difference-in-differences framework that leverages a firm-size discontinuity and individual-level data from the Italian Survey on Household Income and Wealth. Our findings indicate that increased children's job insecurity leads to a reduction in parents' consumption and an increase in savings. This suggests that individuals respond to the heightened job insecurity of their offspring by cutting back on their spending and allocating more of their income towards saving. This mechanism passes through a reduction in their durable expenditure, highlighting how their portfolio preferences change from illiquid to liquid assets.

More precisely, working parents reduce their annual consumption by approximately €2,453. This decrease is mainly driven by a reduction in durable expenses, which decline by €1,600 annually. We do not find any significant variations in their labor supply, both with respect to the intensive and extensive margins. However, we notice that the savings behavior differs depending on the parents' work status. The effect is stronger for retired parents who do not only cut their durable expenses but also reduce their current expenditures.

To the best of our knowledge, only Boar [2021] and Scervini and Trucchi [2022] have examined evidence in support of "dynastic precautionary savings." In her study, Boar [2021] defines income uncertainty as the standard deviation of the forecast error of permanent income

and analyzes a panel of French families. She finds that parents decrease their consumption when their children face higher job insecurity. Also Scervini and Trucchi [2022], using SHARE data, find a significant reduction in parent's savings. We complement their findings in several ways. Firstly, we measure job insecurity as an increase in the expected probability of job loss following a significant reduction in firms' firing costs. Secondly, we make the first attempt to estimate this dynastic precautionary savings channel within a causal framework. Moreover, we demonstrate how this effect influences parents' portfolio selection, resulting in a reshuffling of their assets. We show that they not only reduce their consumption in favor of saving but that this reduction passes through durable consumption expenditure. Lastly, we investigate the effect on parents' labor supply decisions on both the intensive and extensive margins providing supporting evidence on the heterogeneous effect between retired and working parents. By extending the existing literature, our study provides new insights into the relationship between job insecurity, consumption behavior, and savings decisions, specifically focusing on the inter-generational aspect of precautionary savings in the face of labour market transformations.

The paper is structured as follows. Section 3.2 introduces a simple theoretical model to explain the mechanism, while section 3.3 briefly describes the institutional context, the data and the empirical strategy. Section 3.4 outlines the main results, while Section 3.5 presents the robustness checks. Section 3.6 concludes.

3.2 Mechanism

We develop a simple theoretical model to explain the relationship between the rise in children's job insecurity and households' asset preferences. Our model highlights how returns of assets and the possibility of increasing the labor supply impact the households' saving decisions and portfolio dynamics. When the job insecurity of the child increases, parents want to shift their portfolio from illiquid to liquid asset to increase their financial flexibility in preparation for the possible income shock. In this framework, we consider durable goods to be a form of illiquid assets since they are more costly to liquidate than savings. Altruistic parents change their portfolio preferences, increasing savings and decreasing durables, to be able to support their offspring in the case of job loss. The impact is heterogeneous depending on the parents' working status: compared to retired parents, working parents could save less in advance,

since in the case the shock realizes they can immediately adjust their labor supply and use the extra-labor earnings to provide support to their child.

To explain this mechanism, let us consider a two-period model. In the first period ($t = 1$), households decide how much of their income (y_1) they want to invest in the liquid asset (s) and the illiquid asset (d). They make this decision knowing that there is a probability of q that their child might lose their job, and in that case, the household will give her a fixed transfer of size T[1].At the beginning of the second period ($t = 2$), the shock is realized, and households decide how much of their liquid and illiquid asset they want to sell to cope with the liquidity shock. We denote these shares by z and x. Otherwise, if the child keeps the job, the household will hold the assets until the end of the second period and collect the returns. The illiquid asset d gives a return of p if it is held until the end of the second period. If the household liquidates this investment before, he will receive only $p\chi$, with $\chi < 1$. The liquid asset will provide a return of r, regardless of when it is liquidated. Let us assume $p > r > p\chi$. This means that if the illiquid investment is held until the end of the second period, it provides a higher return, while if it has to be liquidated in advance, it is more costly compared to the liquid asset[2].

Households have the option to work more in order to finance the transfer. The amount of work, denoted by l, can range from zero to a maximum value of l_{max}. For every extra unit of hours worked, households will receive a fixed return, ω, which can range from zero to a maximum value of ω_{max}. The transfer amount, T, will be the combination of the revenues obtained by selling the two assets and working extra hours. In the last period, if the child keeps her job, the utility is given by:

$$u(y_2 + rs + pd). \tag{3.1}$$

If the child is unemployed, the parents need to do an immediate transfer out of savings and liquidate a part of the durable stock and face the following maximization problem:

$$\begin{aligned} \max_{z,x,l} \{u(y_2 + r(s - z)) + p(d - x)) - h(l)\} \\ \text{s.t. } p\chi x + zr + \omega l = T, \end{aligned} \tag{3.2}$$

[1]Since we want to focus on the composition of the transfer rather than its size, we consider it as exogenously given.

[2]Similar return structure used by Cooper and Ross [1998].

where u is the utility function with $u' > 0$ and $u'' < 0$, $h(l)$ is the disutility associated with working the extra hours and y_2 is the income in the second period[3]. This problem can be rewritten as follows:

$$\begin{aligned} \max_{x,l} \{u(y_2 + rs - T + p\chi x) + \omega l + p(d - x)) - (h(l))\}. \\ \text{s.t. } zr = T - \omega l - p\chi x, \end{aligned} \tag{3.3}$$

FOC wrt l:

$$\omega u'(c_2) = h'(l) \tag{3.4}$$

FOC wrt x:

$$(p\chi - p)u'(c_2) = 0, \tag{3.5}$$

this problem do not have an interior solutions since Equation 3.5 cannot hold for $\chi < 1$, implying that $x^* = 0$. However, this can be a solution only if in the first period households find optimal to save enough to pay the transfer only through the combination of savings and labor supply. As we prove in Appendix C, given the return structure ($p > r$), households will never find it optimal to save enough to cover the transfer without selling the durable goods. Therefore, in the second period they face the following maximization problem:

$$\begin{aligned} \max_{x,l} \left\{ u(y_2 + p(d - \frac{T - \omega l - rs}{p\chi})) - (h(l)) \right\}. \\ \text{s.t. } p\chi x = T - \omega l - rs, \end{aligned} \tag{3.6}$$

FOC wrt l:

$$\frac{\omega}{\chi} u'(c_2) = h'(l) \tag{3.7}$$

from this we can derive the optimal extra-labor supply l^{**} and the optimal share of durable good households need to sell to pay the transfer $x^{**} = \frac{T - sr - \omega l^{**}}{p\chi}$.
Let us now solve the first period problem with this optimal choices:

$$\begin{aligned} \max_{s,d} \{q[u(y_2 + p(d - x^{**})) - h(l^{**})] + (1 - q)u(y_2 + rs + pd)\}. \\ \text{s.t. } x^{**} = \frac{T - sr - \omega l^{**}}{p\chi}, \\ y_1 = d + s \end{aligned} \tag{3.8}$$

[3] y_2 can be considered as the optimal labor income in the absence of the shock and we assume that is given throughout the period so the immediate transfer cannot be paid off that way.

This problem can be rewritten as follows:

$$\max_{s} \left\{ q[u(y_2 + p(y_1 - s - x^{**})) - h(l^{**})] + (1-q)u(y_2 + rs + p(y_1 - s)) \right\}. \\ \text{s.t. } x^{**} = \frac{T - sr - \omega l^{**}}{p\chi}, \\ d = y_1 - s \tag{3.9}$$

FOC wrt s:

$$(\frac{r}{\chi} - p)qu'(c_{2,u}) + (r-p)(1-q)u'(c_{2,e}) = 0, \tag{3.10}$$

since $\frac{r}{\chi} - p > 0$ and $(r-p) < 0$ this problema has an interior solution.
To understand the effect of an increased probability of the child losing their job on savings let us use the Implicit Function Theorem and label the left-hand side of Equation 3.10 as F. From this we can compute

$$\frac{dF}{ds} = (\frac{r}{\chi} - p)^2 qu''(c_{2,u}) + (r-p)^2(1-q)u''(c_{2,e}) < 0, \tag{3.11}$$

$$\frac{dF}{dq} = (\frac{r}{\chi} - p)u'(c_{2,u}) - (r-p)u'(c_{2,e}) > 0 \tag{3.12}$$

which implies $\frac{ds}{dq} > 0$ since

$$\frac{ds}{dq} = -\frac{\frac{dF}{ds}}{\frac{dF}{dq}} > 0. \tag{3.13}$$

Therefore, when the job insecurity of the child increases parents responds increasing their saving and reducing their durable consumption.
To explain the different responses between retired and working parents, let us assume that for the former group, the productivity of working one extra hour is equal to 0 (i.e., $\omega = 0$). Let us compute $\frac{dF}{d\omega}$ to analyze the effect of an increase of ω on savings.

$$\frac{dF}{d\omega} = \frac{\omega}{\chi}(\frac{r}{\chi} - p)^2 qu''(c_{2,u}) < 0 \tag{3.14}$$

and therefore

$$\frac{ds}{d\omega} = -\frac{\frac{dF}{ds}}{\frac{dF}{d\omega}} < 0. \tag{3.15}$$

As shown in Equation 3.15, the higher the productivity of working an extra hour, the lower the savings. Since retired parents cannot adjust their labor supply, they will compensate by increasing their savings to give the transfer to their child.

3.3 Empirical Analysis

3.3.1 Institutional setting

Before moving to the empirical analysis, we provide a brief overview of the evolution of the Italian labor market regulation that led to the introduction of the Fornero Reform.

The Labor Rights Statute was introduced in Italy in 1970 with the aim of regulating various aspects of the employment relationship, such as workplace safety, minimum wage, and firing procedures. Article 18 of the Statute specifically addressed dismissal procedures for firms with more than 15 employees. Employees working for these firms could be fired only in cases of "just cause", like workers' misconduct or the company needing to reorganize or downsize. This law rendered dismissal very costly for the firms. First, they had to give the notice of dismissal based on the duration of the employment relationship. Second, if the court ruled in favor of the worker, she could choose between a severance package consisting of 15 months' salary plus the foregone earnings between the dismissal and the court's decision, or reinstatement with the amount of foregone earnings. Lastly, since the definition of "just cause" was extremely broad, the court's verdict was often characterized by high uncertainty. As Ichino, Polo, and Rettore [2003] highlights, this high level of discretion for the judges often results in significant variation across cases and labor markets over time.

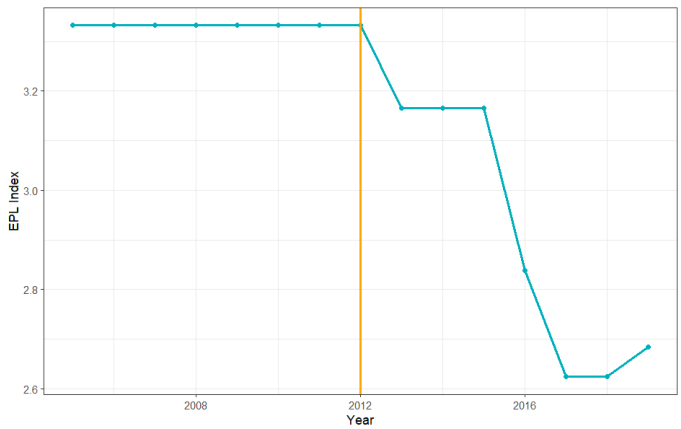
At the same time, the firing procedure for firms with less than 15 employees was defined only in 1990 with the passage of Law 108/1990. Even if the Law 108/1990 restricted the dismissal procedure, the level of employment protection of workers employed in these firms was still lower compare to larger firms. Similarly to firms with more than 15 employees, they too have to provide due notice, and in cases of unfair dismissal, if the court rules in favor of the worker, she can be reinstated or receive a severance package. However, the severance

package amount was lower, ranging from 2.5 to 6 months' salary, and it was decided in advance. Moreover, the choice between being reinstated or receiving the payments was up to the employer rather than the employee.

During the late 1990s, governments implemented various types of fixed-term contracts to address high unemployment rates and increase labor market flexibility. However, these policies led to a labor market that is heavily segmented, with some workers enjoying full employment protection while others, such as those on fixed-term contracts, facing high job instability (De Paola, Scoppa, et al. [2020]).

The Fornero reform (Law 92/2012) aimed at promoting open-ended contracts by making dismissals easier and weakening workers' compensation even if the court ruled that the dismissal was unfair. Restrictions on firing were only reduced for firms with more than 15 employees. This was achieved by limiting the choice between severance payment and reinstatement, reducing the amount of monetary compensation, shortening the duration of litigation, introducing an out-of-court conciliation service, and providing a more restrictive and precise definition of "unfair dismissal" to reduce trial uncertainty (which had an average duration of 72 months before the reform (Ichino, Polo, and Rettore [2003])). Overall, this reform significantly reduced firing costs for firms with more than 15 employees (Sestito and Viviano [2016]) while also lowering the employment protection[4].

Figure 3.1 Evolution of strictness of dismissal for regular contracts



Source: OECD, Employment Protection Legislation (EPL) database

[4]A similar reform was implemented in China in the late 1990s. The reform sharply reduced the employment protection of SOE employees, leaving it unchanged for government workers. He, Hui and Huang, Feng and Liu, Zheng and Zhu, Dongming [2018], exploiting the higher job insecurity introduced by the reform for SOE workers, show that treated households increased their savings in response to an increase in their own job insecurity.

Figure 3.1 illustrates that starting from 2012, employment protection legislation (EPL) strictness in Italy significantly decreased following the implementation of the Fornero Reform. While similar labour market reforms have been common across European countries, Italy serves as an ideal case study for our analysis due to its unique characteristics. Firstly, Italy has historically had a high level of employment protection, making the substantial reduction in EPL a significant shock to the economy. Moreover, studies indicate that Italy, like other Mediterranean countries, has strong family ties (Reher [2004], Frattola [2023]). In such a context, it is reasonable to assume that the labour market status of one family member can influence the choices and decisions of other family members.
These factors make Italy a good case study to examine the decisions and coping strategies adopted by parents when their children face increased job insecurity resulting from significant labour market transformations.

3.3.2 Data description

Our data source is the Survey on Household Income and Wealth (SHIW), a representative sample of the Italian population. SHIW is run by Bank of Italy every two years and around 7000 households are surveyed at each wave. SHIW is a repeated cross sectional data that has a panel component. Not all households are interviewed in the subsequent waves. At each given wave, share of households in the panel component represent 50% of the sample. Exploiting the panel dimension reduces our sample size considerably, which is why we conduct our baseline analysis with the repeated cross section, considering four waves (2008-2014).[5]

The survey collects information on a wide range of economic variables at the household and individual level. Households in our sample report detailed information on their amount and source of income, their consumption, assets and liabilities. We furthermore have individual level information on the people residing in the dwelling. For these people, we observe age, gender, relationship to the householder, education, employment status, income, occupation, and type of contract if the person is employed. The survey includes a question on the interval of the number of employees in the individual's work place in whole of Italy. Since 2008, the individual can respond if the her firm is either a public firm, or has 1) less than 4, 2)5-15, 3) 16-19, 4)20-49, 5) 50-99, 6)100-499 or 7) more than 500 employees. This question allows us to use the threshold of 15 employees in order to determine treatment and control variables.

[5]We stopped at 2014 to avoid overlapping with another huge market reform, the Jobs Act.

Since we can only observe these information for children who reside with the parents, we restrict our sample to this subset. However, compared to their European counterparts, young Italians tend to leave their parents' home at a later age. According to Eurostat (2022), the average age of youth emancipation in Europe is 26.5 years, while in Italy it is 30.1 years. This sub-sample of the population of young adults who still live with their parents accounts for 69.4 percent of young individuals aged 18 to 34 years[6].

We furthermore restrict our sample to households where at least one adult child is working at a firm on a permanent contract. We consider a household treated if there is at least one of the adult children employed at a firm with more than 15 employees in Italy. The control group is composed by households where all of the adult children are employed at firms that have less than 15 employees. After cleaning the data and restricting the sample to our population of interest, we end up with 1763 observations, with 894 in the control group and 869 in the treatment.

Table C.1 in the Appendix presents the summary statistics between the treatment and control group. Households of the treated group displays a slightly elevated percentage of individuals with college and postgraduate degrees. Geographically, a noteworthy divergence emerges, with a majority in the treated group hailing from the Northern regions, contrasting with a higher representation from the South and Islands in the control group. Notably, these units exhibit not only greater wealth but also higher liabilities, indicating a potentially different financial behavior compared to the control group. The higher wealth suggests that these households might be more financially stable or have accumulated more assets, which could imply a certain level of economic security. However, the presence of higher liabilities hints at a willingness or capacity to take on more debt, suggesting a relatively lower financial constraint compared to the control group.

3.3.3 Empirical Strategy

In order to identify the effect an increase in children job insecurity had on households' consumption-saving and labour supply decisions we employ a difference-in-difference (DID) design leveraging a significant labor market reform (Fornero Reform) that sharply reduced the employment protection of workers employed in firms with more than 15 employees. We study the effect on several outcomes. Firstly, we estimate the effect on total consumption

[6]Source: Statistica Research Department, 2023

and then we split it between durables and non-durables expenditure. We then consider the effect on total saving. Lastly we study the effect on the intensive and extensive margins of the labor choices. The former is measured as the variation in the monthly working hours while the latter is the probability that parents change their employment status after the treatment. The following equations represents the main specification of the model we estimate.

$$y_{it} = \beta_0 + \beta_1 D_{it} + \beta_2 Post_t + \beta_3 Post_t \times D_{it} + \epsilon_{it} \tag{3.16}$$

where y_{it} is the outcome variable of interest of household[7] i at time t, $Post_t$ a dummy variable indicating that the reform is in place[8],D_{it} a dummy variable for the treatment status of the household in a given year. Our coefficient of interest is β_3 which tells us the treatment effect. The identifying assumptions are discussed in the Robustness section.

We first report results that we obtain with this simple regression. We then control for propensity score which we compute using controls such as region, marital status, education level of the householder, number of children in the household, age, age squared, employment status, as well as the child's age and education level (see Tables C.2-C.3 in the Appendix).

For regressions where the outcome variable is consumption or savings, we report the results with income as a control. When controlling for income, we abstract from the child's income. We purposefully separate the regressions in which we control for income as it can be argued that income may be a bad control, if households react to the reform by adjusting their labour supply, which is in fact a channel we explore. However, since income is a crucial component of savings, its inclusion in the regression improves the precision of our estimates. In the Robustness section we present the results without controlling for income. Additionally, we reproduce the analysis by controlling for education instead of income, as education is a good proxy for income and is less prone to endogeneity concerns. We then also report results from the regression where we control for income and we compare retired and working households, to explore the heterogeneity in the response between these two groups.

[7]Given the data structure, we can observe saving and consumption at the household level, while the labor choice is at the individual level.

[8]Considering the timing of the reform and the data structure the variable $Post$ takes value equal to one if $year = 2014$.

3.3.4 Identification assumption

Identification using Difference-in-Differences (DID) relies on the parallel trends assumption, which posits that, in the absence of the reform, the treatment group would have followed the same time trend as the control group for the outcome variable of interest. While both observable and unobservable factors may cause the outcome variable's level to differ between the treatment and control groups, this difference must remain constant over time without the reform. Since the treatment group is only observed post-reform, this assumption is inherently untestable. However, support for the assumption can be garnered by examining pre-reform data to show that both groups exhibit similar patterns before the reform. To investigate potential pre-trends that could challenge the parallel trends assumption, we include leads and lags of the DID variable in our analysis.

Table 3.1 Analysis of consumption and savings responses with leads and lags

	Consumption	Durables	Non durables	Savings
Treated×2008	−1,404.673	395.268	−1,799.941	554.554
	(1,422.316)	(737.520)	(1,150.676)	(1,507.673)
Treated×2010	578.251	895.106	−316.854	−78.858
	(1,518.824)	(787.562)	(1,228.753)	(1,609.973)
Treated×2014	−2,873.341*	−1,134.517	−1,738.824	2,276.814
	(1,642.479)	(851.682)	(1,328.791)	(1,741.049)
Observations	1,763	1,763	1,763	1,763
R^2	0.493	0.048	0.545	0.635
Adjusted R^2	0.490	0.043	0.543	0.633
Residual Std. Error (df = 1754)	11,056.510	5,733.177	8,944.889	11,720.040
F Statistic (df = 8; 1754)	212.840***	10.948***	262.328***	380.692***
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 3.2 Analysis of labour supply response with leads and lags

	Total hours worked	Retired	Employed	In workforce
	OLS	*logistic*	*logistic*	*logistic*
Treated × 2008	1.738	−0.094	0.013	0.053
	(1.549)	(0.211)	(0.208)	(0.208)
Treated × 2010	1.360	−0.239	0.155	0.265
	(1.636)	(0.226)	(0.221)	(0.221)
Treated × 2014	3.360*	0.146	0.009	0.106
	(1.820)	(0.246)	(0.241)	(0.240)
Observations	1,021	2,711	2,711	2,711
R^2	0.021			
Adjusted R^2	0.015			
Log Likelihood		−1,819.811	−1,864.943	−1,871.580
Akaike Inf. Crit.		3,655.622	3,745.885	3,759.159
Residual Std. Error	9.095 (df = 1013)			
F Statistic	3.168*** (df = 7; 1013)			
Note:				*p<0.1; **p<0.05; ***p<0.01

Tables 3.1 and 3.2 present the coefficients derived from the model estimated with leads and lags. The findings suggest an absence of significant differences in consumption, savings, and labor behaviors between treated and control households before the reform[9].

3.4 Main Results

Let us start with the results of the main analysis of how parents respond to their children's increased job insecurity induced by the Fornero reform. As explained in Section 3.2 parents should re-calibrate their current expenditure while bolstering their savings to create a buffer against the prospect of their child experiencing job loss. Table 3.3 summarizes the effect stemming from fluctuations in children's job security on parental consumption and savings behaviors.

The implementation of the reform and the subsequent decrease in job security for children notably prompts parents to curtail their annual total consumption by approximately €2,454[10]. This reduction primarily stems from a decrease in spending on durable goods. Parents cut purchases of durable items, resulting in an approximate annual reduction of €1,600 in this

[9] See also figures C.1-C.5 in the Appendix.

[10] Similar result has been found byBoar [2021] and Scervini and Trucchi [2022].

Table 3.3 Effect on consumption and saving, controlling for income.

	Consumption	Durables	Non durables	Savings
Post	293.329	414.914	−121.585	301.330
	(992.785)	(515.756)	(807.000)	(1,053.290)
Treated	3,017.734***	442.213	2,575.521***	2,096.092***
	(588.288)	(305.619)	(478.199)	(624.141)
Post×Treated	−2,453.980*	−1,600.967**	−853.013	2,040.805
	(1,362.944)	(708.056)	(1,107.889)	(1,446.008)
Income (excl. child's)	0.426***	0.045***	0.381***	0.609***
	(0.011)	(0.006)	(0.009)	(0.011)
Observations	1,763	1,763	1,763	1,763
R^2	0.491	0.041	0.539	0.633
Adjusted R^2	0.490	0.039	0.538	0.632
Residual Std. Error (df = 1758)	11,062.600	5,747.071	8,992.395	11,736.800
F Statistic (df = 4; 1758)	423.729***	18.672***	513.506***	756.958***
Note:				*p<0.1; **p<0.05; ***p<0.01

category. Moreover, the coefficient associated with savings choices, although marginally not significant, demonstrates a similar magnitude to the reduction observed in consumption.

Collectively these results strongly support the principal hypothesis regarding the expenditure patterns of parents. Furthermore, the decline in spending on durable goods might be construed as a shift toward more liquid forms of investment, providing additional insight into parental behavior. Faced with heightened job insecurity for their children, altruistic parents reallocate their savings from less liquid assets to more liquid ones, aiming to enhance their financial flexibility in preparation for a potential income shock.

As discussed in the previous section, to further validate the robustness of our findings, we employ the propensity score matching technique. By utilizing this approach, we aim to minimize any potential biases and confounding factors that could affect our results. The utilisation of propensity score matching allows us to compare units with same likelihood of being treated, enhancing the reliability of our estimates. Upon examining the outcomes presented in Table C.2, we find that the magnitude and significance of the effect persist, indicating that our findings are not sensitive to the chosen methodology.

We then proceed by examining the impact of parental labour choices, both in terms of the amount of work (intensive margin) and the decision to participate in the workforce (extensive

margin). When the job insecurity of the child increases, parents may seek to adapt their labor supply to bolster their current income, thereby enhancing their capacity to save.

Table 3.4 Effect on labor supply

	Total hours worked	Retired	Employed	In workforce
	OLS	*logistic*	*logistic*	*logistic*
Post	-2.869^{***}	-0.148	-0.096	-0.077
	(1.059)	(0.156)	(0.148)	(0.148)
Treated	-1.214^{*}	0.308^{***}	-0.284^{***}	-0.263^{***}
	(0.630)	(0.087)	(0.085)	(0.085)
Treated×Post	2.176	0.259	-0.047	0.002
	(1.514)	(0.205)	(0.200)	(0.199)
Observations	1,021	2,711	2,711	2,711
R^2	0.010			
Adjusted R^2	0.007			
Log Likelihood		$-1,821.899$	$-1,865.654$	$-1,872.753$
Akaike Inf. Crit.		3,651.797	3,739.309	3,753.506
Residual Std. Error	9.131 (df = 1017)			
F Statistic	3.345^{**} (df = 3; 1017)			
Note:				*p<0.1; **p<0.05; ***p<0.01

The results in Table 3.4 do not provide any significant evidence of different behaviour between treated and untreated parents. The coefficients associated to the extensive margins not only are never significantly different than 0, but also point estimates are very close to 0. Therefore, we can reasonably conclude that there is no effect on the extensive margins. On the other hand, even if it is marginally not significant at 10% level, the coefficient of the intensive margins shows demonstrates that parents whose children face a higher expected probability of being fired tend to work approximately 2 additional hours per month compared to the control group. To ensure that our findings are not driven by differences in observable characteristics across the two groups, we conduct the same analysis carrying out a propensity score matching. The results, as presented in Table C.3, align with our previous findings.

The lack of a strong response in the labor decision might stem from the fact that even if the children face a higher probability of being fired, household have already enough resources to cope with the potential income shock and do not need to adjust their labor supply in advance. However, even if the analysis doesn't reveal significant shifts in parental labor choices in the first period, the possibility of adjusting the labour supply after the unemployment shock could potentially allow the household to smooth consumption across different states

without savings. Therefore we investigate how the change in consumption among households without this alternative channel is influenced. In other words, we aim to examine whether households lacking the flexibility to increase their working hours exhibit a similar pattern in their consumption adjustments. To explore this further, we reproduce the analysis adding the interaction between our difference-in-difference coefficient and a dummy that takes value 1 if both parents are retired.

Table 3.5 Effect on consumption and savings depending on parent retirement status, controlling for income

	Consumption	Durables	Non durables	Savings
Post	293.253	414.927	−121.674	301.397
	(992.525)	(515.874)	(806.321)	(1,053.191)
Treated	3,021.035***	441.665	2,579.370***	2,093.178***
	(588.139)	(305.691)	(477.801)	(624.088)
Treated×Post	−1,409.992	−1,774.426**	364.433	1,119.268
	(1,556.805)	(809.165)	(1,264.739)	(1,651.962)
Treated×Post× All Retired	−2,325.091	386.314	−2,711.405**	2,052.380
	(1,677.012)	(871.643)	(1,362.394)	(1,779.516)
Income (excl child's)	0.425***	0.045***	0.380***	0.609***
	(0.011)	(0.006)	(0.009)	(0.011)
Observations	1,763	1,763	1,763	1,763
R^2	0.491	0.041	0.540	0.633
Adjusted R^2	0.490	0.038	0.539	0.632
Residual Std. Error (df = 1757)	11,059.700	5,748.384	8,984.832	11,735.700
F Statistic (df = 5; 1757)	339.545***	14.970***	412.289***	605.946***
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 3.5 provides results highlighting the consumption and savings decisions of households, specifically differentiating between households with both householders retired and those who are not, while controlling for income. Both type of parents lower their durable consumption but the results showcase a disparity in non-durable consumption adjustments between retired and working households. In comparison to working households, retired parents demonstrate a marked and statistically significant reduction in their non-durable consumption expenditure by almost 2,711 euros per year. This distinct pattern in consumption changes sheds light on the behavior of parents lacking the ability to adjust their labor supply, emphasizing their efforts to bolster savings through the sole available channel amidst limitations in labor flexibility.

3.5 Robustness checks

Based on our main findings, an increase in children jobs insecurity leads parents to adjust their consumption expenditure and increase their savings. More precisely, parents shift from illiquid to liquid assets in order to be prepared for the negative child income shock. Despite not finding any strong significant effect on the labor choice, we provide supporting evidence on the fact that parents who cannot adjust that channels reduce also the non-durable consumption. Retired parents not only reallocate their assets between liquid and illiquid but also increase their saving through the only possible channel i.e. lowering current consumption.

In this section, we conduct a series of robustness checks aimed at strengthening the validity of our empirical analysis. These checks serve the dual purpose of bolstering the credibility of our findings and offering additional evidence that highlights the channels through which these adjustments in parental behavior occur.

3.5.1 Is income a bad control?

As anticipated in the previous section, income could potentially serve as a bad control variable for consumption, since it also might be directly influenced by the reform. Indeed, if households increase their labor supply in response to the reform, their labor income mechanically increases. In light of this potential distortion, we sought to enhance the robustness of our findings by replicating the analysis pertaining to consumption and saving decisions, this time without controlling for income.

The analysis presented in Table 3.6 underscores that eliminating income as a control variable has only a marginal effect on the coefficients' magnitudes. Notably, while the coefficient associated with total consumption loses some significance, it still emphasizes a comparable reduction following the reform. Conversely, the coefficient related to durable goods expenditure remains significant and retains a similar magnitude[11].

A similar pattern emerge when we reproduce the analysis controlling for whether the parents are retired or not (see Table C.5 in the Appendix).

[11] In Table C.4 in the Appendix, we also report the results of the analysis taking parents' education as a proxy for income, as it should be correlated with income but is less prone to endogeneity concerns. The results are consistent with our main findings.

Table 3.6 Effect on consumption and saving, no controls.

	Consumption	Durables	Non durables	Savings
Post	227.199	407.915	−180.716	206.759
	(1,368.261)	(525.156)	(1,166.242)	(1,709.668)
Treated	5,891.707***	746.386**	5,145.321***	6,206.090***
	(804.648)	(308.835)	(685.845)	(1,005.423)
Post×Treated	−2,159.200	−1,569.768**	−589.431	2,462.363
	(1,878.391)	(720.951)	(1,601.053)	(2,347.085)
Observations	1,763	1,763	1,763	1,763
R^2	0.032	0.005	0.036	0.032
Adjusted R^2	0.031	0.003	0.035	0.030
Residual Std. Error (df = 1759)	15,246.540	5,851.823	12,995.450	19,050.840
F Statistic (df = 3; 1759)	19.616***	2.888**	22.086***	19.157***
Note:				*p<0.1; **p<0.05; ***p<0.01

3.5.2 Effects on children income

In order to strengthen the robustness of our findings and address potential alternative explanations, we examined additional channels that could potentially drive the observed results. One crucial aspect we explored was the possibility that the effects were driven by changes in children's wages. Given the particular characteristics of our study population, namely parents and children living together, it is essential to consider how an increase in one family member's income might impact the consumption, saving, and working habits of the entire household.
To investigate this, we analyze whether treated children, following the implementation of the Fornero Reform, experienced a reduction or an increase in their wages as a compensatory mechanism for the heightened job insecurity they faced. The objective was to understand whether any observed changes in consumption and savings patterns could be attributed to variations in children's income levels.
The results, as presented in Table 3.7, indicate that we did not find any significant effect of the Fornero Reform on children's wages. This finding supports the notion that the observed changes in consumption and savings behavior among parents cannot be solely attributed to changes in their children's income levels. Rather, it provides further evidence that the changes in parental financial decisions were driven by the increased job insecurity faced by their children, independent of any concurrent changes in their wages.

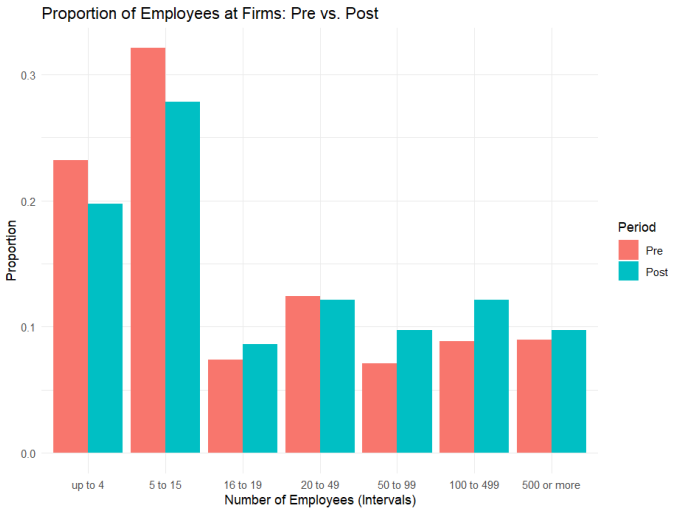
Table 3.7 Effect of the reform on the adult child's labour income

	Child's income
Post	589.290
	(769.138)
Treated	5,347.167***
	(452.315)
Post×Treated	−389.241
	(1,055.896)
Observations	1,763
R^2	0.087
Adjusted R^2	0.086
Residual Std. Error	8,570.508 (df = 1759)
F Statistic	56.170*** (df = 3; 1759)
Note:	*p<0.1; **p<0.05; ***p<0.01

3.5.3 Firm size adjustments

Another potential concern regarding our specification relates to the possibility of firms adjusting their size following the implementation of the reform. With the reduced firing costs associated with the Fornero Reform, it is plausible that firms may choose to increase their size as it becomes less costly to do so. This, in turn, may lead to a shift of some observations from the control group to the treatment group. Importantly, since families whose children work in firms with less than 15 employees tend to consume less on average, this could potentially influence our results.

Figure 3.2 Distribution of firm sizes in the sample before and after the reform



As shown in Figure 3.2 after the implementation of the reform the share of firms with less than 15 employees slightly changes.

To address this issue, we conduct an additional analysis that excludes the ranges right above the threshold (16-19), and compares firms with less than 15 employees to those with more than 20 employees. By implementing this alternative specification, we aim to account for the potential endogenous movement of observations between the control and treatment groups due to changes in firm size.

Table 3.8 Effect on consumption and saving, excluding households close to the threshold

	Consumption	Durables	Non durables	Savings
Post	293.157	415.001	−121.844	301.799
	(1,008.788)	(527.922)	(816.529)	(1,072.629)
Treated	3,647.470***	538.621	3,108.849***	1,772.168***
	(629.439)	(329.400)	(509.478)	(669.273)
Treated×Post	−2,708.765*	−1,619.092**	−1,089.673	2,170.766
	(1,441.240)	(754.233)	(1,166.562)	(1,532.447)
Income (excl. child's)	0.425***	0.046***	0.379***	0.612***
	(0.011)	(0.006)	(0.009)	(0.012)
Observations	1,626	1,626	1,626	1,626
R^2	0.494	0.042	0.542	0.632
Adjusted R^2	0.492	0.039	0.541	0.631
Residual Std. Error (df = 1621)	11,240.920	5,882.626	9,098.581	11,952.290
F Statistic (df = 4; 1621)	394.863***	17.592***	480.500***	695.853***
Note:				*p<0.1; **p<0.05; ***p<0.01

The results of this alternative specification (Table 3.8 and Table 3.9) demonstrate consistency with the main findings. Specifically, we find that parents whose children face higher job insecurity still exhibit a reduction in consumption by an amount of 2,708 euros and of 1,619 euros per year of the durable expenditure, which aligns with the results obtained from the standard specification. Regarding labour choices, we observe coefficients of similar magnitude. Overall, the analysis accounting for potential endogenous firm size adjustments confirms the robustness of our results regarding consumption behavior.

Table 3.9 Effect on labour supply, excluding households close to the threshold

	Total hours worked	Retired	Employed	In workforce
	OLS	*logistic*	*logistic*	*logistic*
Post	−2.628**	−0.151	−0.087	−0.068
	(1.032)	(0.155)	(0.146)	(0.147)
Treated	−1.038	0.363***	−0.323***	−0.312***
	(0.652)	(0.090)	(0.089)	(0.089)
Treated×Post	1.419	0.167	−0.015	0.058
	(1.538)	(0.211)	(0.206)	(0.205)
Observations	965	2,534	2,534	2,534
R^2	0.010			
Adjusted R^2	0.007			
Log Likelihood		−1,695.917	−1,744.459	−1,748.601
Akaike Inf. Crit.		3,399.834	3,496.918	3,505.202
Residual Std. Error	9.049 (df = 961)			
F Statistic	3.211** (df = 3; 961)			
Note:				*p<0.1; **p<0.05; ***p<0.01

3.5.4 Parents' treatment status

An additional potential concern regarding our primary model pertains to the likelihood of parents adjusting their job insecurity in response to their individual shocks rather than solely in response to their children's situation. To address this, we refine our main model by incorporating controls for the parents' treatment status[12].

As depicted in Table 3.10, the significance and magnitude of our primary coefficients of interest remain consistent and unaffected by the inclusion of controls for the parents' treatment status. This observation suggests that even after accounting for potential adjustments in parents' job insecurity, the estimated impacts on consumption and savings decisions attributed to changes in their children's job security, induced by the reform, remain robust and unchanged.

[12]We also restrict the sample to parents that are never treated. As Table C.6 shows this will reduce the sample size, but the magnitude and significance of the results remains unchanged.

Table 3.10 Effect on consumption and labour supply, controlling for parents' treatment status

	Consumption	Durables	Non-durables	Savings	Hours worked
Post	171.923	558.011	−386.089	−283.797	−4.011***
	(1,085.283)	(562.840)	(882.886)	(1,147.956)	(1.528)
Treated	3,020.701***	441.682	2,579.019***	2,100.383***	−1.406**
	(588.075)	(304.982)	(478.403)	(622.035)	(0.636)
Treated×Post	−2,456.402*	−1,588.280**	−868.122	1,995.949	1.814
	(1,362.645)	(706.683)	(1,108.521)	(1,441.335)	(1.538)
Treated_p	963.194	978.338***	−15.145	−2,491.093***	1.359*
	(631.495)	(327.501)	(513.726)	(667.963)	(0.702)
$\text{Treated}_p \times \text{Post}$	466.267	−428.295	894.562	1,837.911	1.798
	(1,471.775)	(763.279)	(1,197.299)	(1,556.767)	(1.721)
Income (excl child's)	0.422***	0.042***	0.380***	0.616***	
	(0.011)	(0.006)	(0.009)	(0.011)	
Observations	1,763	1,763	1,763	1,763	1,021
R^2	0.492	0.046	0.539	0.636	0.017
Adjusted R^2	0.490	0.043	0.537	0.634	0.012
Note:					*p<0.1; **p<0.05; ***p<0.01

3.6 Conclusions

The link between the economic status of parents and the outcomes of their children is by no means an uncharted territory. Several studies shown a correlation between parental and children's income over time, as well as the effect of parental income on children's educational achievements (Solon [1992], Blau [1999], Shea [2000], Chevalier, Harmon, O'Sullivan, and Walker [2013]). However, the reciprocal relationship between children's economic status and parental financial conditions is often neglected.

This study highlights how children's job security fluctuation can significantly impact parental consumption and saving decisions. Furthermore, we show how these effects pass through restructuring parental portfolios towards more liquid assets.

To determine how parents adjust their consumption, saving, and labor choices in response to their children's heightened job insecurity, we leveraged the significant labor reform introduced in Italy in 2012, known as the Fornero Reform. This reform substantially reduced firing costs for firms with over 15 employees, and we employed a difference-in-differences approach

to assess its impact. Additionally, we examined how these adjustments vary depending on the retirement status of the parents.

Our findings show that working parents of treated children reduce their total consumption by approximately €2,453 per year. This reduction is primarily driven by a decrease in durable consumption by €1,600 per year. While we do not observe significant effects on the intensive and extensive margins of work, comparing consumption-saving responses between retired and working parents highlights that retired parents reduce durable consumption and cut current expenditures to provide a financial safety net for their children.

Our analysis highlights the importance of recognizing the unintended consequences of young adults's job insecurity. While the direct effects of an increase in job insecurity are well-known, our findings illustrate a ripple effect that extends to the financial decisions and overall well-being of their parents. The research suggests that the economic stability of adult children has a significant impact on the financial trajectory of their parents, since parents' financial decisions are closely tied to the fortunes of their children. As a result, parents often find themselves shouldering an additional burden, adjusting their consumption, saving, and investment strategies in response to the changing economic landscape.

With this paper, we made a first attempt to causally estimate the interplay between children's labor outcomes and parents' financial decisions, highlighting how this shapes their investment choices. However, we faced some limitations in our analysis. First, we were only able to estimate the effect for families where children still live with their parents due to data constraints. Although this group constitutes nearly 70% of the Italian population aged between 18 and 34, our findings may be overestimated. Moreover, since we can only observe savings and consumption choices at the household level, we cannot clearly pinpoint the effective reduction of parents' expenditures. Future research that uses panel data to observe all young adults for a longer period could reveal other important aspects and further support our conclusions.

References

Adda, Jérôme and A Triggari (2016). "Labor Market Inequalities across Italian Demographic Groups: a focus on the youth and the long-term unemployed". In: *Policy Brief* 1.

Aerts, Kris and Tobias Schmidt (2008). "Two for the price of one?: Additionality effects of R&D subsidies: A comparison between Flanders and Germany". In: *Research policy* 37.5, pp. 806–822.

Aggarwal, Raj and Sijing Zong (2006). "The cash flow–investment relationship: International evidence of limited access to external finance". In: *Journal of Multinational Financial Management* 16.1, pp. 89–104.

Akerlof, George A (1978). "The market for "lemons": Quality uncertainty and the market mechanism". In: *Uncertainty in economics*. Elsevier, pp. 235–251.

Altonji, Joseph G, Fumio Hayashi, and Laurence J Kotlikoff (1997). "Parental altruism and inter vivos transfers: Theory and evidence". In: *Journal of political economy* 105.6, pp. 1121–1166.

Becker, Sascha O et al. (2010). "Youth emancipation and perceived job insecurity of parents and children". In: *Journal of population Economics* 23, pp. 1047–1071.

Blau, David M (1999). "The effect of income on child development". In: *Review of Economics and Statistics* 81.2, pp. 261–276.

Bloch, Carter (2005). "R&D investment and internal finance: The cash flow effect". In: *Economics of Innovation and New Technology* 14.3, pp. 213–223.

Boar, Corina (2021). "Dynastic precautionary savings". In: *The Review of Economic Studies* 88.6, pp. 2735–2765.

Boeri, Tito and Juan F Jimeno (2015). "Unemployment in Europe: what does it take to bring it down?" In: *ECB forum on central banking, Sintra*, pp. 21–23.

Broecker, Thorsten (1990). "Credit-worthiness tests and interbank competition". In: *Econometrica: Journal of the Econometric Society*, pp. 429–452.

Broekel, Tom (2015). “Do cooperative research and development subsidies stimulate regional innovation efficiency? Evidence from Germany”. In: *Regional studies* 49.7, pp. 1087–1110.

Bronzini, Raffaello and Eleonora Iachini (2014). “Are incentives for R&D effective? Evidence from a regression discontinuity approach”. In: *American Economic Journal: Economic Policy* 6.4, pp. 100–134.

Bronzini, Raffaello and Paolo Piselli (2016). “The impact of R&D subsidies on firm innovation”. In: *Research Policy* 45.2, pp. 442–457.

Bushman, Robert M, Abbie J Smith, and Frank Zhang (2011). “Investment cash flow sensitivities really reflect related investment decisions”. In: *Available at SSRN 842085*.

Carpenter, Robert E and Bruce C Petersen (2002a). “Capital market imperfections, high-tech investment, and new equity financing”. In: *The Economic Journal* 112.477, F54–F72.

— (2002b). “Is the growth of small firms constrained by internal finance?” In: *Review of Economics and statistics* 84.2, pp. 298–309.

Chevalier, Arnaud et al. (2013). “The impact of parental income and education on the schooling of their children”. In: *IZA Journal of Labor Economics* 2, pp. 1–22.

Choi, HwaJung, Kathleen McGarry, and Robert F Schoeni (2016). “Consumption and the extended family”. In: *Economics Letters* 140, pp. 34–38.

Clark, Andrew, Conchita D’Ambrosio, and Anthony Lepinteur (2022). “Job insecurity, savings and consumption: an Italian experiment”. In.

Cooper, Russell and Thomas W Ross (1998). “Bank runs: Liquidity costs and investment distortions”. In: *Journal of monetary Economics* 41.1, pp. 27–38.

Czarnitzki, Dirk and Hanna Hottenrott (2011). “R&D investment and financing constraints of small and medium-sized firms”. In: *Small business economics* 36.1, pp. 65–83.

Czarnitzki, Dirk and Katrin Hussinger (2004). “The link between R&D subsidies, R&D spending and technological performance”. In: *ZEW-Centre for European Economic Research Discussion Paper* 04-056.

David, Paul A, Bronwyn H Hall, and Andrew A Toole (2000). “Is public R&D a complement or substitute for private R&D? A review of the econometric evidence”. In: *Research policy* 29.4-5, pp. 497–529.

De Paola, Maria, Vincenzo Scoppa, et al. (2020). “Fertility decisions and employment protection: The unintended consequences of the Italian Jobs Act”. In.

Feldman, Maryann P and Maryellen R Kelley (2006). “The ex ante assessment of knowledge spillovers: Government R&D policy, economic incentives and private firm behavior”. In: *Research policy* 35.10, pp. 1509–1521.

Fogli, Alessandra (2004). *Endogenous labor market rigidities and family ties*. Tech. rep. mimeo New York University.

Frattola, Edoardo (2023). *Parental retirement and fertility decisions across family policy regimes*. Temi di discussione (Economic working papers) 1417. Bank of Italy, Economic Research and International Relations Area.

Gelman, Andrew and Guido Imbens (2019). “Why high-order polynomials should not be used in regression discontinuity designs”. In: *Journal of Business & Economic Statistics* 37.3, pp. 447–456.

Gilchrist, Simon and Charles P Himmelberg (1995). “Evidence on the role of cash flow for investment”. In: *Journal of monetary Economics* 36.3, pp. 541–572.

Girma, Sourafel, Holger Görg, and Eric Strobl (2007). “The effect of government grants on plant level productivity”. In: *Economics Letters* 94.3, pp. 439–444.

González, Xulia and Consuelo Pazó (2008). “Do public subsidies stimulate private R&D spending?” In: *Research Policy* 37.3, pp. 371–389.

Harhoff, Dietmar and Timm Körting (1998). “Lending relationships in Germany–Empirical evidence from survey data”. In: *Journal of Banking & Finance* 22.10-11, pp. 1317–1353.

Hayashi, Fumio, Joseph Altonji, and Laurence Kotlikoff (1996). “Risk-sharing between and within families”. In: *Econometrica: Journal of the Econometric Society*, pp. 261–294.

He, Hui and Huang, Feng and Liu, Zheng and Zhu, Dongming (2018). “Breaking the “iron rice bowl:” evidence of precautionary savings from the Chinese state-owned enterprises reform”. In: *Journal of Monetary Economics* 94, pp. 94–113.

Hellgren, Johnny, Magnus Sverke, and Kerstin Isaksson (1999). “A two-dimensional approach to job insecurity: Consequences for employee attitudes and well-being”. In: *European Journal of Work and Organizational Psychology* 8.2, pp. 179–195.

Hess, Gregory D (2004). “Marriage and consumption insurance: What’s love got to do with it?” In: *Journal of Political Economy* 112.2, pp. 290–318.

Himmelberg, Charles P and Bruce C Petersen (1994). “R & D and internal finance: A panel study of small firms in high-tech industries”. In: *The review of economics and statistics*, pp. 38–51.

Hottenrott, Hanna and Sarah Demeulemeester (2017). “R&D subsidies and firms’ cost of debt”. In.

Hottenrott, Hanna, Elmar Lins, and Eva Lutz (2018). “Public subsidies and new ventures’ use of bank loans”. In: *Economics of Innovation and New Technology* 27.8, pp. 786–808.

Howell, Sabrina T (2017). “Financing innovation: Evidence from R&D grants”. In: *American Economic Review* 107.4, pp. 1136–64.

Ichino, Andrea, Michele Polo, and Enrico Rettore (2003). “Are judges biased by labor market conditions?” In: *European Economic Review* 47.5, pp. 913–944.

Jaffe, Adam B (2002). “Building programme evaluation into the design of public research-support programmes”. In: *Oxford Review of Economic Policy* 18.1, pp. 22–34.

Kamien, Morton I and Nancy L Schwartz (1978). “Self-Financing of an R and D Project”. In: *The American Economic Review* 68.3, pp. 252–261.

Karhunen, Hannu and Janne Huovari (2015). “R&D subsidies and productivity in SMEs”. In: *Small business economics* 45.4, pp. 805–823.

Kleer, Robin (2010). “Government R&D subsidies as a signal for private investors”. In: *Research Policy* 39.10, pp. 1361–1374.

Lee, David S and Thomas Lemieux (2010). “Regression discontinuity designs in economics”. In: *Journal of economic literature* 48.2, pp. 281–355.

Lerner, Josh (2000). “The government as venture capitalist: the long-run impact of the SBIR program”. In: *The Journal of Private Equity* 3.2, pp. 55–78.

Li, Jun, Ruby P Lee, and Junbao Wan (2020). “Indirect effects of direct subsidies: an examination of signaling effects”. In: *Industry and Innovation* 27.9, pp. 1040–1061.

Link, Albert N and John T Scott (2013). “Public R&D subsidies, outside private support, and employment growth”. In: *Economics of Innovation and New Technology* 22.6, pp. 537–550.

Lugilde, Alba, Roberto Bande, and Dolores Riveiro (2017). “Precautionary Saving: a review of the theory and the evidence”. In.

Marino, Francesca and Luca Nunziata (2017). “The labor market in Italy, 2000-2016”. In: *IZA World of Labor*.

Meuleman, Miguel and Wouter De Maeseneire (2012). “Do R&D subsidies affect SMEs’ access to external financing?” In: *Research Policy* 41.3, pp. 580–591.

Mistrulli, Paolo Emilio et al. (2023). "Job protection and mortgage conditions: evidence from Italian administrative data". In: *Oxford Bulletin of Economics and Statistics* 85.6, pp. 1211–1237.

O'Reilly, Jacqueline et al. (2015). "Five characteristics of youth unemployment in Europe: Flexibility, education, migration, family legacies, and EU policy". In: *Sage Open* 5.1, p. 2158244015574962.

Ranjan, Priya (1999). "Fertility behaviour under income uncertainty". In: *European Journal of Population/Revue Européenne de Démographie* 15, pp. 25–43.

Reher, David S (2004). "Family ties in Western Europe: persistent contrasts". In: *Strong Family and Low Fertility: A Paradox? New Perspectives in Interpreting Contemporary Family and Reproductive Behaviour*. Springer, pp. 45–76.

Scervini, Francesco and Serena Trucchi (2022). "Intergenerational precautionary savings in Europe". In: *Oxford Bulletin of Economics and Statistics* 84.2, pp. 427–450.

Sestito, Paolo and Eliana Viviano (2016). "Hiring incentives and/or firing cost reduction? Evaluating the impact of the 2015 policies on the Italian labour market". In: *Evaluating the Impact of the 2015 Policies on the Italian Labour Market (March 18, 2016). Bank of Italy Occasional Paper* 325.

Shea, John (2000). "Does parents' money matter?" In: *Journal of public Economics* 77.2, pp. 155–184.

Solon, Gary (1992). "Intergenerational income mobility in the United States". In: *The American Economic Review*, pp. 393–408.

Spence, A Michael (1979). "Investment strategy and growth in a new market". In: *J. Reprints Antitrust L. & Econ.* 10, p. 345.

Takalo, Tuomas and Tanja Tanayama (2010). "Adverse selection and financing of innovation: is there a need for R&D subsidies?" In: *The Journal of Technology Transfer* 35.1, pp. 16–41.

Wei, Jiang and Yan Zuo (2018). "The certification effect of R&D subsidies from the central and local governments: evidence from China". In: *R&D Management* 48.5, pp. 615–626.

Weiss, Yoram (1997). "The formation and dissolution of families: Why marry? Who marries whom? And what happens upon divorce". In: *Handbook of population and family economics* 1, pp. 81–123.

Appendix A

Appendix to Chapter 1

Proof Proposition 1

Bank's profits in this case can be describe by the following equation

$$\Pi_j(\lambda, k) = (\lambda r(\lambda) - 1)(I - k) \; \forall \lambda, k.$$

For each λ they makes non-negative profits as long as the interest rate they offer is greater or equal to $\frac{1}{\lambda}$.

As in the standard Bertrand competition models, it is easy to prove that $r(\lambda) = \frac{1}{\lambda}$ is the only possible Nash-equilibrium of this game. Let us first see if there are any profitable deviations. If both j chooses that interest rate, they are making zero profits. Neither of them can gain by raising its interest rate because firms won't accept this offer (thereby, still zero profits). If a bank posts an interest rate below $\frac{1}{\lambda}$ it will attract more firms but it will make negative profits. Let us moreover check that this equilibrium is unique. In order to do this, let us consider different cases:

1. Suppose that the lower of the two interest rate is less than $\frac{1}{\lambda}$. In this case the j offering this will incur in losses. However, by raising the interest rate just above $\frac{1}{\lambda}$, the worst it can do is earning zero profits. $\rightarrow$ Profitable deviation

2. Suppose without loss of generality $r_{j=1}(\lambda) = \frac{1}{\lambda}$ and $r_{j=2}(\lambda) > \frac{1}{\lambda}$ for a given λ. In this way Bank 1 will sell to the entire market making profits equal to 0. However, if it starts offering $r_1 = \frac{1}{\lambda} + \frac{r_2 - \frac{1}{\lambda}}{2}$, it will make positive profits. $\rightarrow$ Profitable deviation

3. Suppose both offer $r_j \geq \frac{1}{\lambda}$. Wlg $r_{j=1} \leq r_{j=2}$. In this way Bank 2 can make at most profits equal to $\frac{1}{2}[(\lambda r_j - 1)(1-k)]$. However, by setting $r_{j=2} = r_{j=1} - \epsilon$ it will get all the market. $\rightarrow$ Profitable deviation

Therefore, both j will offer the same interest rate in both periods and this interest rate will be such that both of them break-even. Let us look at firms optimal response given this interest rate.

$$\lambda(R - \tfrac{1}{\lambda}(I-k)) \geq k$$

$$\lambda R - I \geq 0$$

Let us define as λ^* the value of λ such that $\lambda^* R = I$. It is straightforward to see that all firms with $\lambda \geq \lambda^*$ will always accept banks offer independently of their k while firms with $\lambda < \lambda^*$ will find profitable to reject it.

Q.E.D

Proof Proposition 2

For each firm banks can infer the probability of success of their project only from the noisy information they have about it $\mathcal{H}$. Let us rewrite the banks profits in this scenario as :

$$\Pi_j(\lambda, k) = (E(\lambda|\mathcal{H})r(\lambda) - 1)(I-k) \; \forall \lambda, k.$$

From the previous equation we can see that banks makes non-negative profits only if $r_j(\mathcal{H}) \geq \frac{1}{E(\lambda|\mathcal{H})}$. Since banks share the same information, the standard Bertrand argument can also be applied in this case. Therefore both of them will post an interest rate equal to $\frac{1}{E(\lambda|\mathcal{H})}$.

Now let us start considering the case where $E(\lambda|\mathcal{H}) \geq \lambda^*$. Firms will accept the offer if and only if:

$$\lambda(R - \tfrac{1}{E(\lambda|\mathcal{H})}(I-k) \geq k$$

Rewriting the previous equation we can see that firms will accept banks' offer if and only if $k(\lambda - E(\cdot)) \geq \lambda(I - E(\cdot)R)$. The right-hand side of this equation is always non-positive since $E(\cdot)R \geq I$ for every $E(\cdot) \geq \lambda^*$. The left-hand side takes different signs depending on whether a firm has a project with a probability of success greater or lower than λ^*. From this, we can see that firms with projects with a probability greater than λ^* (i.e. those for which the

left-hand side is positive) will always accept banks offer while the others will accept only if $k(\mathcal{H}) \leq \frac{\lambda(r^*(\mathcal{H})I-R)}{\lambda r^*(\mathcal{H})-1}$.

Instead, if $E(\lambda|\mathcal{H}) < \lambda^*$ the result will be different. Let us look again at this equation: $k(\lambda - E(\cdot)) \geq \lambda(I - E(\cdot)R)$. Now, the right-hand side is always non-negative since $E(\cdot)R < I$ for every $E(\cdot) < \lambda^*$. Firms with $\lambda < \lambda^*$ will never invest indipendently of their k while firms with $\lambda \geq \lambda^*$ will invest only if $k(\mathcal{H}) \geq \frac{\lambda(r^*(\mathcal{H})I-R)}{r^*(\mathcal{H})\lambda-1}$.

Q.E.D

Proof Proposition 3

In the first period banks can observe two different outcomes from their tests. Let us starting considering the case where j observe l as a signal for a given project. Applying Bayes rule they will know with probability one that this i is a λ_L-type.

$$\beta(\lambda_L \mid l) = \frac{P(l|\lambda_L)P(\lambda_L)}{(P(l|\lambda_L)P(\lambda_L)+P(l|\lambda_H)P(\lambda_H))} = \frac{(1-\alpha)\phi}{(1-\alpha)\phi+0} = 1$$

Therefore, for the same reasoning explained in the the continuous case firms with this projects will find optimal to reject it. Formally, they will invest only if

$$\lambda_L(R - \tfrac{1}{\lambda_L}(I-k) \geq k$$
$$\lambda_L R - I + k \geq k$$
$$\lambda_L R - I \geq 0$$

which is not possible given the way we have defined λ_L.

Suppose now that $s_j = h$. Bank's profits in this case are equal to:

$$\Pi_j = \beta(\lambda_H \mid h)(\lambda_H r_j - 1) + (1 - \beta(\lambda_H \mid h))(\lambda_L r_j - 1)](I-k)$$

where

$$\beta(\lambda_H \mid h) = \frac{P(h|\lambda_H)P(\lambda_H)}{(P(h|\lambda_H)P(\lambda_H)+P(h|\lambda_L)P(\lambda_L))} = \frac{\alpha}{\alpha+(1-\alpha)(1-\phi)}.$$

From this we can derive that the minimum interest rate such that they make positive expected profits is:

$$r_j \geq \frac{1}{\beta(\lambda_H|h)\lambda_H+(1-\beta(\lambda_H|h))\lambda_L} = \frac{1}{E(\lambda_H|h)}$$

However, since banks share the same information, the standard Bertrand argument can also be applied in this case. Therefore both of them will post an interest rate equal to $\frac{1}{E(\lambda_H|h)}$. Since we focus only on the case where $E(\lambda_H|h) < \lambda^*$, firms with λ_H projects invest only if $k(h) \geq \frac{\lambda_H(r^*(h)I_1 - R_1)}{r_1^*(h)\lambda_H - 1}$

Q.E.D

Proof Proposition 4

The reasoning behind the proof of Proposition 3 can be easily applied to understand also this variation of the game. As before, none of the firms for which either banks observe l or $G = 0$ will invest since because in both cases banks know with certainty that they are facing a λ_L-type since only this type can send l as a signal.

Suppose now, that j observes $s_j = h$. Here we have two different scenarios:

1. If $G = 0$, then j knows that it is mistakenly considering a λ_L as a λ_H and it will update its beliefs and offer $\frac{1}{\lambda_L}$. At this interest rate, firms with these projects will find optimal to reject the offer.

2. If $G = S$, then j knows that with some probability the government and itself could still make a mistake, but it will reinforce its beliefs about the quality of the project i.e.

$$\beta(\lambda_H \mid h, h)) = \frac{P(\lambda_H)P(h|\lambda_H)P(h|\lambda_H)}{P(\lambda_H)P(h|\lambda_H)P(h|\lambda_H)+P(\lambda_L)P(h|\lambda_L)P(l|\lambda_L)} = \frac{\alpha}{\alpha+(1-\alpha)(1-\phi)(1-\bar{\phi})}.$$

Hence it will offer $\frac{1}{E(\lambda_H|h,h)}$, with $E(\lambda_H|h,h) = \beta(\lambda_H \mid h, h))\lambda_H + (1 - \beta(\lambda_H \mid h, h))\lambda_L$. This depends on the usual Bertrand argument and on the fact that now each bank is making an offer to borrowers that on average are less risky.

From λ_H-type's side,as before, all λ_H-type firms with $k \geq k(h, h)$ will develop the R&D project

$$\lambda_H R - \frac{\lambda_H}{E(\lambda_H|h,h)}(I-k) + S = 0$$
$$k(h,h) \geq I - E(\lambda_H|h,h)R - \frac{E(\lambda_H|h,h)}{\lambda_H}S$$

where $k(h,h) < k(h)$ independently of the potential reduction of the interest rate.

Q.E.D

Proof Proposition 5

Using backward induction, let's describe the potential information available to the banks at time $T = 2$.

- $\mathcal{H}_2 = (\cdot, l)$: If $s_2 = l$ banks will offer as an interest rate $\frac{1}{\lambda_L}$ independently of what has happened in the first period, since the l signals perfectly reveal the type of the project. At this interest rate all firms find optima to reject the offer for the same reasoning explained in the previous proofs.

- $\mathcal{H}_2 = (0, h)$: If banks observe $s_2 = h$ and $P = 0$ that means that firms has not developed any projects in the previous period. For these firms banks cannot infer anything about their type in the previous period. Therefore, they will offer as interest rate $r_2^* = \frac{1}{E(\lambda_H|h)}$ which is equal to r_1^*. These firms will accept only if $k_2 \geq k_2(h,0) = \frac{\lambda_H(r_2^*(h,0)I_2 - R_2)}{r_2^*(h,0)\lambda_H - 1}$.

- $\mathcal{H}_2 = (1, h)$: If banks observe that the firms has developed the project in the first period i.e. $P = 1$ they can infer that it had a λ_H project in that period. They will update they beliefs as follows:

  $$P(\lambda_H|h,1) = \frac{\rho\alpha}{\rho\alpha + (1-\alpha)(1-\phi)(1-\rho)}$$

  They will offer as interest rate $E(\lambda_H|h,1)$ and all the firms with $k_2 \geq k_2(h,1) = \frac{\lambda_H(r_2^*(h,1)I_2 - R_2)}{r_2^*(h,1)\lambda_H - 1}$ will invest.

Let us move to the first stage of the game. Since firms are short-run players they only care about current profits. Therefore, they will invest following the same strategies described in the static game. Banks do not have any reasons to deviate to the static equilibrium because in both periods they make the same profits.

Q.E.D

Proof Proposition 6

As explained in Proof 5, in the second stage of the game banks can either observe l as signal, and then know for sure that the firm has a project with a low probability of success, or observe h and the development of the project. They will offer an interest rate according to the information available, as described in the previous proof and firms will behave accordingly.

In the first stage, the Government will provide the subsidy and banks observing its decisions update their beliefs as described in Proof 4. All firms with high quality projects pay a lower interest rate in the first period. Moreover, for firms with $k_1 \in [k_1(hh), k_1(h)]$ and a successful R&D project ($P = 1$) banks apply a lower interest rate in the second period. This reduction in the cost of debt is the reputation effect induced by the government grants that helps firms with low initial capital to invest and let their project signal their quality in the future.

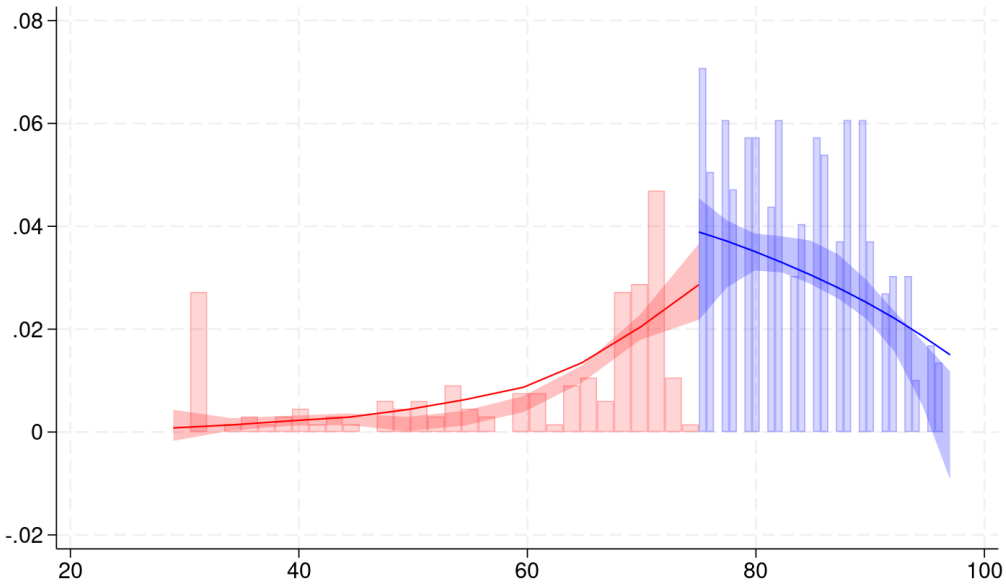
Q.E.D

Appendix B

Appendix to Chapter 2

Density discontinuity test

Figure B.1 Density discontinuity test



Appendix C

Appendix to Chapter 3

Descriptive statistics

Table C.1 Summary descriptives table by treatment groups

	Control N=894	Treated N=869	p-value
Municipality population:			0.021
Up to 5,000 inhabitants	124 (13.9%)	129 (14.8%)	
From 5,000 to 20,000 inhabitants	169 (18.9%)	216 (24.9%)	
From 20,000 to 50,000 inhabitants	275 (30.8%)	254 (29.2%)	
From 50,000 to 200,000 inhabitants	256 (28.6%)	211 (24.3%)	
More than 200,000 inhabitants	70 (7.83%)	59 (6.79%)	
Age (Householder)	58.0 (7.89)	59.7 (7.63)	<0.001
Highest educational achievement:			.
None	17 (1.90%)	10 (1.15%)	
Elementary school	241 (27.0%)	204 (23.5%)	
Middle school	431 (48.2%)	404 (46.5%)	
High school	177 (19.8%)	201 (23.1%)	
College degree	26 (2.91%)	49 (5.64%)	
Postgraduate degree	2 (0.22%)	1 (0.12%)	
Area:			<0.001
North	375 (41.9%)	513 (59.0%)	
Centre	207 (23.2%)	170 (19.6%)	
South and Islands	312 (34.9%)	186 (21.4%)	
Marital status:			0.472

continued on next page

Table C.1 – *continued from previous page*

	Control N=894	Treated N=869	p-value
Single/Never Married	5 (0.56%)	3 (0.35%)	
Married	707 (79.1%)	707 (81.4%)	
Divorced/Widowed	182 (20.4%)	159 (18.3%)	
Area of birth:			<0.001
North	297 (34.5%)	421 (50.3%)	
Centre	181 (21.0%)	144 (17.2%)	
South and Islands	383 (44.5%)	272 (32.5%)	
Labor market status:			<0.001
Unemployed	38 (4.25%)	49 (5.64%)	
Employee	312 (34.9%)	227 (26.1%)	
Self-employed	95 (10.6%)	91 (10.5%)	
Retired	335 (37.5%)	411 (47.3%)	
Homemaker	114 (12.8%)	91 (10.5%)	
Real estate	230300 (275092)	303397 (400834)	<0.001
Businesses	29079 (241342)	55183 (379536)	0.086
Valuables	3923 (9035)	5443 (13709)	0.006
Real assets	263302 (414432)	364022 (682964)	<0.001
Net wealth	278011 (431974)	408107 (845099)	<0.001
Financial assets	23996 (57282)	56726 (266678)	<0.001
Financial liabilities	9344 (29246)	12803 (47639)	0.067
Household wealth group (quintiles)	3.33 (1.31)	3.61 (1.31)	<0.001
Household wealth group (deciles)	6.17 (2.64)	6.73 (2.66)	<0.001
Total consumption	28068 (12307)	33530 (17772)	<0.001
Consumption of transport equipment	1425 (4798)	1814 (6020)	0.134
Consumption of other durables	576 (1842)	630 (1622)	0.516
Durable c	2001 (5326)	2444 (6360)	0.113
Non-durable c	26067 (10361)	31086 (15228)	<0.001
Savings excluding income from financial assets	15072 (14226)	21233 (20348)	<0.001
Savings	15200 (14526)	21912 (22794)	<0.001
Fringe benefits	21.7 (152)	58.1 (514)	0.045
Net wages	5828 (8993)	5144 (11146)	0.157
Total labour earnings	5850 (9035)	5202 (11414)	0.187
Pensions and other transfers	5964 (9155)	8758 (10769)	<0.001
Net income from self-employment	2639 (9157)	3064 (11336)	0.387
Income from rents	6812 (5816)	8713 (9361)	<0.001

continued on next page

Table C.1 – *continued from previous page*

	Control N=894	Treated N=869	p-value
Net individual income, excluding income from assets	21265 (14365)	25737 (22036)	<0.001
Property income	6939 (6230)	9392 (13632)	<0.001
Net individual income	21393 (14799)	26416 (25204)	<0.001
Net family income, excluding income from assets	43140 (19755)	54764 (29726)	<0.001
Income group (quantiles)	4.04 (1.01)	4.43 (0.82)	<0.001
Income group (deciles)	7.61 (2.03)	8.46 (1.67)	<0.001
Net family income	43268 (20171)	55442 (32358)	<0.001
Number of workers of the firm in Italy:			<0.001
Up to 4	47 (14.8%)	17 (7.20%)	
5-15	84 (26.5%)	37 (15.7%)	
16-19	19 (5.99%)	16 (6.78%)	
20-49	22 (6.94%)	23 (9.75%)	
50-99	24 (7.57%)	18 (7.63%)	
100-499	16 (5.05%)	26 (11.0%)	
500+	23 (7.26%)	39 (16.5%)	
Public	82 (25.9%)	60 (25.4%)	
Contract type:			0.335
Permanent	288 (90.9%)	220 (93.2%)	
Fixed term	27 (8.52%)	13 (5.51%)	
Temporary	2 (0.63%)	3 (1.27%)	

Propensity score

Table C.2 Effect on consumption and saving, controlling for income and the propensity score.

	Consumption	Durables	Non durables	Savings
Post	−97.624	367.529	−465.153	−9.669
	(973.378)	(515.873)	(788.342)	(1,042.395)
Treated	1,201.308*	222.054	979.254**	651.148
	(612.828)	(324.788)	(496.331)	(656.280)
Post×Treated	−2,494.251*	−1,605.848**	−888.403	2,008.770
	(1,334.885)	(707.465)	(1,081.128)	(1,429.535)
Income (excl. child's)	0.413***	0.043***	0.369***	0.598***
	(0.011)	(0.006)	(0.009)	(0.011)
Propensity score	12,554.290***	1,521.635**	11,032.650***	9,986.778***
	(1,442.872)	(764.696)	(1,168.586)	(1,545.178)
Observations	1,763	1,763	1,763	1,763
R^2	0.512	0.043	0.561	0.641
Adjusted R^2	0.511	0.040	0.560	0.640
Residual Std. Error (df = 1757)	10,834.780	5,742.239	8,775.125	11,603.020
F Statistic (df = 5; 1757)	368.529***	15.755***	449.226***	627.966***
Note:				*p<0.1; **p<0.05; ***p<0.01

Table C.3 Effect on labour supply decisions, controlling for the propensity score

	Total hours worked	Retired	Employed	In workforce
	OLS	*logistic*	*logistic*	*logistic*
Post	−2.860***	−0.247	−0.028	−0.015
	(1.063)	(0.160)	(0.150)	(0.150)
Treated	−1.189*	−0.066	0.010	0.001
	(0.665)	(0.095)	(0.092)	(0.092)
Treated×Post	2.175	0.275	−0.045	0.003
	(1.515)	(0.210)	(0.203)	(0.202)
Propensity score	−0.188	2.672***	−2.101***	−1.871***
	(1.655)	(0.238)	(0.228)	(0.226)
Observations	1,021	2,711	2,711	2,711
R^2	0.010			
Adjusted R^2	0.006			
Log Likelihood		−1,754.744	−1,821.705	−1,837.487
Akaike Inf. Crit.		3,519.488	3,653.410	3,684.973
Residual Std. Error	9.135 (df = 1016)			
F Statistic	2.510** (df = 4; 1016)			
Note:				*p<0.1; **p<0.05; ***p<0.01

Identification assumption

Figure C.1 Response of total consumption to the reform, with leads and lags

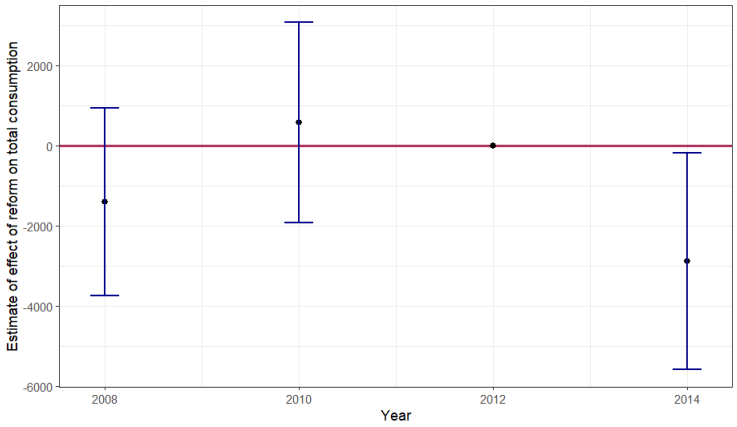


Figure C.2 Response of durable consumption to the reform, with leads and lags

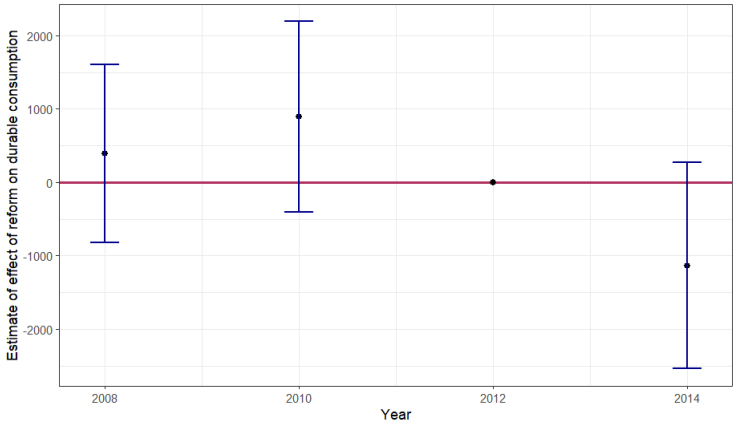


Figure C.3 Response of non-durable consumption to the reform, with leads and lags

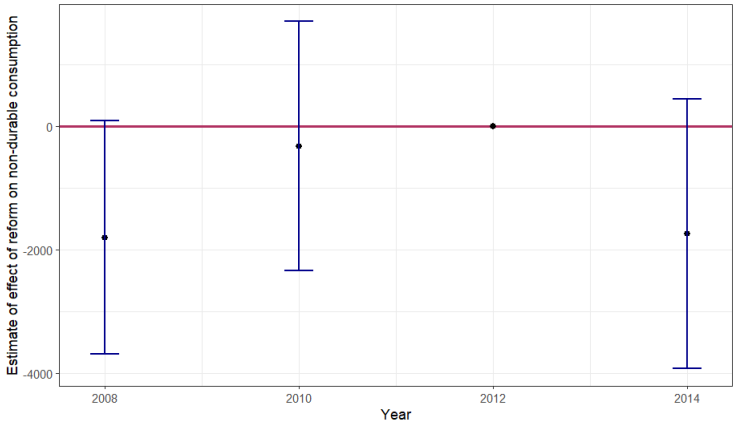


Figure C.4 Response of savings to the reform, with leads and lags

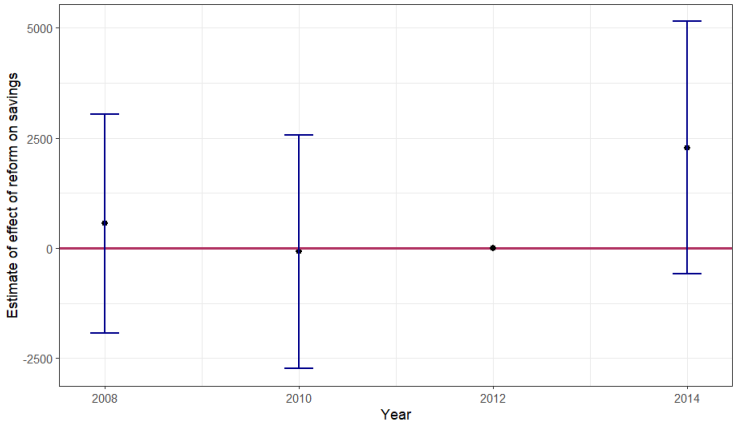
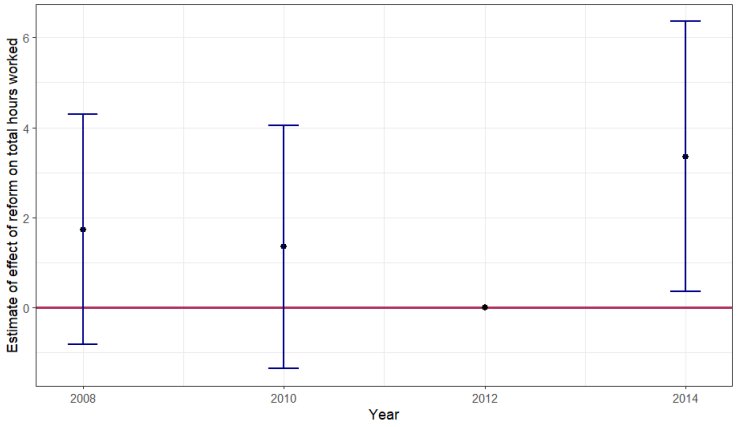


Figure C.5 Response of hours worked to the reform, with leads and lags



Effect on consumption and savings controlling for education

Table C.4 Effect on consumption and labour supply, controlling for education as a proxy for income

	Consumption	Durables	Non durables	Savings
Post	−1190.40	235.90	−1426.31	−900.93
	(1239.70)	(521.52)	(1049.01)	(1650.72)
Treated	4770.11***	610.29**	4159.82***	5329.70***
	(730.03)	(307.10)	(617.74)	(972.067)
Post×Treated	−1486.47	−1469.20**	−17.27	2935.28
	(1701.30)	(715.69)	(1439.62)	(2265.36)
Education	7765.56 ***	942.28***	6823.28 ***	6067.83***
	(392.33)	(165.05)	(331.99)	(522.41)
Observations	1,763	1,763	1,763	1,763
R^2	0.209	0.023	0.223	0.100
Adjusted R^2	0.207	0.021	0.221	0.098
Residual Std. Error (df = 1758)	3.341	5.91	2.392	5.924
F Statistic (df = 4; 1758)	115.88***	10.33***	126.03***	49.00***
Note:				*p<0.1; **p<0.05; ***p<0.01

Effect on consumption and saving depending on parent retirement status, without controls

Table C.5 Effect on consumption and saving depending on parent retirement status, without controls

	Consumption	Durables	Non durables	Savings
Post	227.199	407.915	−180.716	206.759
	(1,367.160)	(525.301)	(1,164.705)	(1,710.084)
Treated	5,891.707***	746.386**	5,145.321***	6,206.090***
	(804.001)	(308.920)	(684.941)	(1,005.668)
Post×Treated	−130.071	−1,638.562**	1,508.491	2,953.055
	(2,143.976)	(823.776)	(1,826.486)	(2,681.749)
Post×Treated×All Retired	−4,520.590*	153.262	−4,673.852**	−1,093.188
	(2,308.760)	(887.090)	(1,966.868)	(2,887.865)
Observations	1,763	1,763	1,763	1,763
R^2	0.034	0.005	0.039	0.032
Adjusted R^2	0.032	0.003	0.037	0.030
Residual Std. Error (df = 1758)	15,234.270	5,853.437	12,978.310	19,055.480
F Statistic (df = 4; 1758)	15.694***	2.172*	18.020***	14.397***
Note:				*p<0.1; **p<0.05; ***p<0.01

Effect on consumption and labour supply, with never-treated parents

Table C.6 Effect on consumption and labour supply, with never-treated parents

	Consumption	Durables	Non-durables	Savings	Hours worked
Post	340.427	495.081	−154.654	−162.586	−1.659
	(1100.618)	(517.775)	(935.563)	(1,215.233)	(1.820)
Treated	3,730.309***	687.685**	3,042.624***	1,496.51**	−5.358***
	(663.502)	(312.126)	(563.999)	(732.598)	(1.088)
Treated×Post	−2,973,459*	−1,471.196**	−1,322.263.	1,231.17	0.109
	(1,517.791)	(714.002)	(1,290.174)	(1,675.85)	(2.510)
Income (excl child's)	0.429***	0.029***	0.400***	0.598***	
	(0.012)	(0.006)	(0.010)	(0.013)	
Observations	1,204	1,204	1,204	1,204	1,204
R^2	0.543	0.029	0.578	0.636	0.026
Adjusted R^2	0.533	0.025	0.577	0.635	0.023
Residual Std. Error (df = 1199)	1.232	2.796	8.749	1.489	
F Statistic (df = 4; 1199)	332.65***	9.12*	401.74***	551.86***	

Note: *p<0.1; **p<0.05; ***p<0.01

Proof

In order to show that for the household is never optimal to pay the transfer without selling the durable goods, let us solve the first period problem and check if $s > T - \omega l_{max}$.

$$\begin{aligned} \max_{s,d} \{q[u(y_2 + r(s-z) + \omega l_{max} + pd) - h(l_{max})] + (1-q)u(y_2 + rs + pd)\}. \\ \text{s.t. } sr + \omega l_{max} - T \geq 0, \\ y_1 = d + s \end{aligned} \tag{C.1}$$

Using the fact that $d = y_1 - s$ we can rewrite the problem as follows:

$$\begin{aligned} \max_{s,d} \{q[u(y_2 + r(s-z) + \omega l_{max} + p(y_1 - s)) - h(l_{max})] + (1-q)u(y_2 + rs + p(y_1 - s))\}. \\ \text{s.t. } sr + \omega l_{max} - T \geq 0, \\ d = y_1 - s \end{aligned} \tag{C.2}$$

FOC wrt s:

$$(r-p)[qu'(c_{2,u}) + (1-q)u'(c_{2,e})] - r\lambda = 0, \tag{C.3}$$

since $r < p$ the Lagrangian multiplier is non-positive for every l. Households never find optimal to save enough to cover the transfer without selling the durable goods.

Q.E.D