**UNIVERSITY OF PIRAEUS**

SCHOOL OF ECONOMICS, BUSINESS AND INTERNATIONAL STUDIES

DEPARTMENT OF ECONOMICS

# Essays on Innovation and Finance

**Ph.D. Thesis**

**Dimitrios Konstantios**

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**Dimitrios Konstantios**

**Supervisor: Claire Economidou**

**Professor of Economics**

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# Essays on Innovation and Finance

**Ph.D. Thesis**

**Dimitrios Konstantios**

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**Piraeus, 2018**

I would like to dedicate this thesis to my family….

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# Abstract

Innovation is a crucial factor for a country's competitive position in international markets and a powerful driver for long-run economic growth. The present Thesis comprises of three essays that analyze the role of innovation and sustainability of in firms' financial performance as well as the effect of capital restrictions on firms' ability to finance their innovation projects. More specifically, the first essay investigates the role of innovation performance and firms' reconcilability through trademarks in firm's longevity and IPO underpricing. Based on a sample of 2,275 US IPOs from 1997-2016 the findings that on average the presence of trademarks in a firm's portfolio increases underpricing, post IPO performance and longevity. The second essay proceeds further by examining the effect of disclosing sustainability information about the environmental, social and governance practices of firms before their IPO on underpricing as well as their post IPO performance. The core statement of the analysis is that sustainability acts as risk mitigation mechanism by reducing asymmetric information. Using a sample of 854 US IPOs from 2008-2017, the findings support that firms which disclose sustainability information on average face less underpricing and is more likely to remain listed in the stock market for longer. Finally, the third easy looks at the constraints of innovation instead. As discussed in previous essays, innovation is important for firms' performance. However, in presence of capital restrictions firms may face difficulties in performing substantial innovation activity. The third essay, therefore, studies the role of financial restrictions in shaping innovation activity. To unfold the effects of capital controls on R&D, uses a new data set that differentiates between controls on inflows and on outflows as well as among asset categories for 54 developed and developing economies over the period 1995-2013. The findings clearly demonstrate that capital controls are detrimental for R&D activity; however, their overall effect may vary depending on the level of financial development and technology of a country. High level of development in the financial sector smooths out some of the adverse effects of capital restrictions on R&D, while countries with high-tech export orientation could be more sensitive to capital restrictions. Overall, capital controls affect more negatively technologically advanced economies with less developed financial markets. Finally, the choice on whether controls should be imposed on capital inflows or outflows may also have different implications on the innovation activity.

Particularly, restrictions on money market and commercial credit are by far the most damaging for innovation.

# ΠΕΡΙΛΗΨΗ

Η καινοτομία είναι ένας καθοριστικός παράγοντας για την ανταγωνιστική θέση μιας χώρας στις διεθνείς αγορές και αποτελεί ισχυρό μοχλό για μακροπρόθεσμη οικονομική ανάπτυξη. Η παρούσα διδακτορική διατριβή αποτελείται από τρία δοκίμια, τα οποία αναλύουν το ρόλο της καινοτομίας στην απόδοση της επιχείρησης καθώς και την επίδραση των ελέγχων κεφαλαίου στην ικανότητα των επιχειρήσεων να χρηματοδοτούν σημαντικά έργα καινοτομίας. Πιο συγκεκριμένα, το πρώτο δοκίμιο ερευνά την επίδραση της καινοτομίας και της αναγνωσιμότητάς των επιχειρήσεων, μέσω των εμπορικών σημάτων στην μακροβιότητα της επιχείρησης και στην τιμολόγηση κατά την διαδικασία εισαγωγής στο χρηματιστήριο. Υποστηρίζεται ότι η δραστηριότητα των εμπορικών σημάτων είναι πιο πιθανό να αυξήσει την υποτιμολόγηση της τιμής πρώτης προσφοράς στις επιχειρήσεις που ανήκουν στους κλάδους υπηρεσιών, ενώ είναι λιγότερο ή καθόλου πιθανό να αυξήσει την υποτιμολόγιση στις επιχειρήσεις που ανήκουν σε βιομηχανικούς κλάδους. Με βάση ένα δείγμα που αποτελείται από 2.275 αμερικάνικες εισαχθείσες επιχειρήσεις από το 1997 έως το 2016 και καταλήγουμε ότι η παρουσία των εμπορικών σημάτων στο χαρτοφυλάκιο μιας επιχείρησης αυξάνει κατά μέσο όρο την υποτιμολόγηση κατά την διαδικασία εισαγωγής τους στο χρηματιστήριο . Το δεύτερο δοκίμιο επεκτείνει την ανάλυση εξετάζοντας την επίδραση της δημοσιοποίησης της πληροφόρησης για τη βιωσιμότητα μιας επιχείρησης, σχετικά με την υποτιμολόγηση της τιμής των μετοχών πριν από την αρχική δημόσια προσφορά. Ιδιαίτερα, διερευνά τον αντίκτυπο της πληροφόρησης που αφορά την περιβαλλοντική, κοινωνική και εταιρική διακυβέρνηση (βιωσιμότητα) στην αποτίμηση, στη χρηματοδότηση και στην απόδοση και την μακροβιότητα της επιχείρησης. Γίνεται η υπόθεση ότι το βιωσιμότητα των επιχειρήσεων λειτουργεί ως εργαλείο άμβλυνσης του κινδύνου, μειώνοντας το πρόβλημα της ασύμμετρης πληροφόρησης. Τα ευρήματα, χρησιμοποιώντας ένα δείγμα από 854 αμερικάνικες επιχειρήσεις με IPO από το 2008 έως το 2017, υποστηρίζουν ότι οι επιχειρήσεις που αποκαλύπτουν πληροφορίες σχετικά με την βιωσιμότητα τους αντλούν κεφάλαια κατά μέσο όρο με καλύτερους όρους και είναι πιο πιθανό να παραμείνουν εισηγμένες για μεγαλύτερο χρονικό διάστημα. Τέλος, το τρίτο δοκίμιο μελετάει τους περιορισμούς της καινοτομίας. Όπως αναφέρθηκε στα προηγούμενα δοκίμια, η καινοτομία είναι σημαντική για την απόδοση των επιχειρήσεων. Παρόλα αυτά, οι επιχειρήσεις, με την παρουσία των περιορισμών κεφαλαίου, ενδέχεται να αντιμετωπίσουν δυσκολίες στην πραγματοποίηση δραστηριότητας καινοτομίας. Επομένως το τρίτο δοκίμιο μελετά το ρόλο των κεφαλαιακών περιορισμών και των χρηματοοικονομικών εργαλείων στη διαμόρφωση της καινοτομίας. Για να ξεπεραστούν οι επιπτώσεις των ελέγχων κεφαλαίου στην έρευνα και ανάπτυξη χρησιμοποιείται ένα νέο σύνολο δεδομένων που διαφοροποιεί τον έλεγχο των εισροών και των εκροών καθώς και μεταξύ των κατηγοριών

των περιουσιακών στοιχείων για 54 ανεπτυγμένες και αναπτυσσόμενες οικονομίες κατά την περίοδο 1995-2013. Τα ευρήματα δείχνουν σαφώς ότι οι έλεγχοι κεφαλαίου είναι επιβλαβής για τη δραστηριότητα της έρευνας και ανάπτυξης. Ωστόσο, η συνολική τους επίδραση μπορεί να ποικίλει ανάλογα με το επίπεδο της χρηματοπιστωτικής ανάπτυξης και τεχνολογίας μιας χώρας. Το υψηλό επίπεδο ανάπτυξης του χρηματοπιστωτικού τομέα εξομαλύνει ορισμένες από τις αρνητικές επιπτώσεις των περιορισμών κεφαλαίου στην έρευνα και ανάπτυξη ενώ οι χώρες με προσανατολισμό τις εξαγωγές σε προϊόντα υψηλής τεχνολογίας θα μπορούσαν να είναι πιο ευαίσθητες σε περιορισμούς κεφαλαίου. Συνολικά, οι έλεγχοι κεφαλαίου επηρεάζουν αρνητικά τις περισσότερο προηγμένες τεχνολογικά οικονομίες με λιγότερο αναπτυγμένο χρηματοπιστωτικό σύστημα. Τέλος, η επιλογή του κατά πόσο οι έλεγχοι θα πρέπει να επιβάλλονται στις εισροές ή στις εκροές κεφαλαίων μπορεί επίσης να έχει διαφορετικές επιπτώσεις στη δραστηριότητα της καινοτομίας. Ιδιαίτερα, οι περιορισμοί στην χρηματοδότηση και στην εμπορική πίστωση είναι μακράν οι πιο επιβλαβείς.

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# Chapter 1

# Introduction

## 1.1 Motivation

The present Thesis consists of three chapters that independently study the relationship between finance and innovation. Specifically, the Thesis aims to bring novel insights on the effect of innovation and sustainability on firm's financial performance. As innovation is a key driver of growth, the present Thesis also explores the role of financial frictions (capital controls) on financing innovation. More specifically firms in their quest for funding their projects, they may decide to enter the public market for equity funds to supplement borrowed funds and retained earnings. Initial Public Offerings (IPOs) is the first sale of new or existing private shares to new investors. The IPOs constitute an important milestone concerning the ability of an enterprise to become recognizable and to propel its growth by increasing its financing capabilities. It is a strategic and financial entrepreneurial decision with long lasting effects on the future prospects of the firm itself. The literature thus far has not fully investigated the effect of two alternative innovation vehicles on underpricing. The first, represented by trademarks, is considered as innovation around the product. The other is related with procedural and strategic innovation and is represented by sustainability. Both, relate to the resolution of information asymmetry. Thus, is extremely intriguing to examine how these different vehicles of innovation are market internalized during and after the IPO procedure. To perform innovation and sustainable practices may not always be possible especially in the presence of financial restrictions. Thus, far, there is scant evidence in the field concerning the effects of capital controls on economic growth via the channel of funding firms' innovation activities.

## 1.2 Structure of the Thesis

The structure of the present Thesis is as follows:

Chapter 1 analyzes and empirically tests the impact of trademarks -existing prior to the IPO- on firms' valuation during the IPO procedure as well as their post IPO performance. Trademarks constitute one of the most important activities that companies can incorporate in their business strategy to help consumers identify their innovative products or services. A successful such strategy can generate substantial benefits and increase the firm's value. However, trademarks that represent soft intensive innovation around the product are intangible and hence difficult to value. While the intangibility aspect of trademarks increases, on one hand, the uncertainty among investors and therefore has the potential of increasing the underpricing of the issue, on the other hand, trademarks may result in superior post IPO performance and lengthens firm's survival time in the stock market. The present chapter examines the role of trademarks in firm's IPO underpricing, post IPO performance and longevity. Trademarks can be associated with physical products or services. The chapter further explores whether firm's trademark activity in the service industries is more likely to increase underpricing compared to manufacturing firms. Empirical evidence based on 2,275 US IPOs over the period 1997-2016 shows that on average the presence of trademarks in a firm's portfolio increases the IPO underpricing, especially in the services, the post IPO performance and longevity.

Chapter 2 extents Chapter 1 by examining the effect of firms disclosing sustainability information before the IPO on their underpricing, post IPO performance and longevity. Sustainability is a concept encompassing three dimensions. The first dimension is related to the firm's sensitivity concerning environmental protection, the second refers to social responsibility and the third to the quality of corporate governance. Firms which actively implement technologies and social and corporate policies in harmony to human and environmental needs fulfilling their present and future potential are considered as sustainable. Sustainability has the ability of reducing risk and asymmetric information concerns about the value of the firm. Investors and other corporate stakeholders may take a keen interest in sustainable firms when the economy faces systematic crises and economy-wide trust levels fall. This uncertainty mitigation potential of sustainability could be present during the IPO procedure and influence the extent of the underpricing. Sustainability disclosure may have consequences concerning the post IPO performance and longer survival in the stock market. Based on a sample of 854 US IPOs from 2008-2017, the evidence shows that firms which disclose sustainability information, on the average, face less underpricing in general and is more likely to remain listed for longer compared to their peers.

Finally, Chapter 3 studies take a different look and explores the effects of capital controls on innovation performance. The recent global financial crisis of 2008 spurred reconsideration of the role of capital restrictions. The prevailing view among economists has been that financial liberalization is beneficial, while financial restrictions are nearly bad. Capital controls, however, are making an intellectual comeback and becoming part of the policy discussion once again. After long urging countries to free the movement of capital, the international monetary fund (IMF) surprised markets and economic policy makers by endorsing and even recommending the use of controls in some cases when countries have few other options. Other prominent calls have gone further towards a greater acceptance of the use of capital controls as a regular tool of policy. Some of these policy prescriptions are consistent with a new branch of theoretical research in which capital controls contribute to financial stability and macroeconomic management. Nevertheless, these theoretical works stand in contrast to a large number of empirical analyses that emphasize the ineffectiveness and potential costs of capital controls to major aspects of economic activity. To unfold the effects of capital controls on innovation, the chapter employs a new data set that differentiates between controls on inflows and on outflows as well as among asset categories for 54 developed and developing economies over the period 1995-2013. The findings clearly demonstrate that there is a negative association between capital controls and R&D performance; the effect of capital controls, however, may vary depending on the level of financial development and technology of a country. High level of development in the financial sector smooths out some of the adverse effects of capital restrictions on R&D, while countries with high-tech export orientation could be more sensitive to capital restrictions. Further, the choice on whether controls should be imposed on capital inflows or outflows may also have different implications on the innovation activity. Finally, restrictions on money market and commercial credit are by far the most damaging.

# Chapter 2

# Trademarks, Firm Longevity and IPO Underpricing

## 2.1 Introduction

Trademarks (TMs) constitute one of the most important activities that companies can incorporate in their business strategy to help consumers identify their innovative products or services. A successful such strategy can generate substantial benefits and increase the firm's value. Further, companies may encompass TMs in their general business strategy to generate and display new brands, labels, names, signatures, shapes of goods and new packaging before the major decision to list in the stock exchange. Box Inc., a Red wood City, California, based company involved in cloud storage and file hosting for personal accounts and businesses was intensifying its effort in 2014 to finalize its offering. Interestingly, the firm chose the previous two years to introduce fourteen trademarks from a total of twenty-three that had historically in order to promote its image in the market. Box Inc was listed on the 23rd of January 2015 and it was heavily underpriced by 65.93% leaving $115.37 million on the table.

Innovation is one of the key drivers that motivates companies to list in order to advance their competitive advantage and therefore increase profitability (Griliches, 1998; Hall et al., 1993; Cao et al., 2015) while several studies have underlined the importance of TMs in firm's innovative activity (Allegrezza and Guarda-Rauchs, 1999; Jensen and Webster, 2009; Schmoch, 2003; Millot, 2012). Further, since the seminal works of Schechter (1927) and more recently Hodsdon (2007), research has extensively investigated the importance of TMs in corporate events e.g., (Sandner and Block, 2011; Block et al., 2014, 2015; Bernstein, 2015).

Trademarks can generate revenues in companies aiming to list by achieving recognition from public, by licensing the logos or brand name to third parties, by bringing new technologies onto the markets for products (i.e., product-based commercialization strategies), or by adopting a combination of the two strategies. The literature has not yet examined the impact of trademarks formation in capital raised process during the initial public offering. This raises several interesting questions. Do trademarks increase underpricing because of their intangibility? What if trademarks are related to firm longevity and signaling quality through underpricing?

Motivated by the lack of relative empirical evidence on the subject, we address these questions on the role of trademarks in the IPOs process by examining the relationship between emblems and the returns that those public offerings secure to their investors as well as their survivability in the long term. We use a large and comprehensive sample of U.S. IPOs listed over the period from 1997 to 2016.

We borrow arguments from the asymmetric information literature to predict and explain the role of TMs. On the one hand, TMs, as any intangible asset, may be harder to value ex ante than tangible assets. This can increase the information asymmetry among the participating players (mainly firms, investors and underwriters) which could result in higher underpricing. Further, issuers with TM activity, knowledgeable of their higher quality, may be willing to tolerate underpricing to a greater extent differentiating themselves from firms with no TMs to signal their potentially superior long-term post-IPO performance. These firms will exhibit longer life-span so there is higher probability to raise more funds in more privileged terms.

On the other hand, TMs are associated with the firm's brand, related products and services. Therefore, TMs could help to substantially alleviate uncertainty about company potential and dynamics. This latter argument could result in lower underpricing. Given that there are strong arguments both in favor and against underpricing we point to the need to answer this question empirically.

We further argue that TMs that are associated with products are more likely to reduce information asymmetries than TMs associated with services. Therefore, we posit that TM activity by firms in the service industries is more likely to increase underpricing while in the case of the manufacturing firm's TM activity is less (or not) likely to result to increased underpricing.

Our results show that on average a firm with TM activity experiences a 4% increase in underpricing compared to a firm with no TM activity. Interestingly, we also find strong evidence to support our prediction regarding the presence of TMs in the service and manufacturing industries respectively. Almost exclusively our baseline results are driven by firms in the service sector. This implies a sharp contrast between these two sectors. TMs in the

manufacturing sector can be more readily valued as the outcome of innovative products; a fact that can drive down any information asymmetries. On the contrary, while TMs in the service industry can still represent innovative output in the form of services, the market may be more perplexed as to the exact valuation of such intangible assets. To our knowledge, this is the first study that contrasts the value of TMs between service and manufacturing firms.

We do claim that TM activity by firms, when controlling for all other factors, can have a significant contribution to IPO returns. To this end, one can argue that our results are potentially biased. Therefore, to control for potential bias in our results we sought for potential variables that can be used as instruments. Our only viable instrument is the industry's Market to Book Ratio. While our results are qualitatively similar, such an instrument may not be the ideal candidate. Therefore, to further provide robustness we perform propensity score matching techniques where in essence identify firms without TMs that are similar to firms with TMs. Results from this analysis also corroborate the baseline results.

Additional results from the firm's TM portfolio size complement our baseline results. In the case of the service industry's firms the size of the TM portfolio does not matter; the mere presence of TMs is enough to increase underpricing for these firms. In the case of the manufacturing industry, firms with an average-sized portfolio appear to have higher underpricing compared to firms without TMs and firms with few or many TMs. We argue that for these firms, asymmetric information may be larger as they may not yet able to transcend their products' quality in the same fashion as more TM-experienced firms.

In an important departure from prior studies, we thoroughly examine TMs as the outcome of establishing identifiability for material goods, services as well as firms. From the firm's viewpoint TMs show promise in analyzing (1) links between technological activity and marketing advantages; (2) international patterns of sectoral specialization, (3) rates and directions of product innovations in different industrial sectors, (4) evolution of economic organizations and structures, not only in terms of entry and exit of firms, but also in terms of firm growth, differentiation, and diversification. In this context, firms consider their IPO as part of their strategic portfolio linked to both their innovative and competitive stance and decision making. There are multiple reasons for such a strategy: attracting capital, customers, investors, executives and workers, input suppliers and finally establishing institutional credibility and political support. From the society's viewpoint, TMs are also important for at least three reasons: (1) they confer an exclusive right of using a brand helping companies to appropriate the returns of investing in new products or improve existing ones; (2) they are an important aspect of contemporary culture world-wide; and (3) they are a source of qualitative and quantitative information on socio-economic activity.

This study makes important contributions to the IPOs and financial intermediation literature. First, it provides new evidence on the effect of trademarks, by shedding light on innovative activities of companies in the prior listing period and their determination of success after going public. Specifically, we find that firms that involve on trademark activity are more underpriced in comparison to their peers without trademarks. We show that the evidence of quality is undervalued during the formation of the finalized offer price providing support to Hall (1993) and Hall et al. (1993)which suggest that investors might be myopic in pricing the future cash flows from innovations, leading to undervaluation. (Huberman and Regev, 2001; Hirshleifer et al., 2013) show that investors with limited attention may fail to reflect innovation information into stock prices, leading to undervaluation. Second, to our knowledge, this is the first study to explicitly account for the long-term performance of companies which involve on trademark creation prior listing. Third, our study offers new insights on the influence of TM introduction on the probability of failure and survivability of initial public offering (IPO) firms. Our findings also have important implications for issuers. For instance, we provide justification that companies should demonstrate creativity prior going public and ability to convert creativity through capital raised into successful projects. This is consistent with the notion that the success of the trademark in the market signals the quality of its services.

Our study is related to the works of (Heeley et al., 2007; Krasnikov et al., 2009; Sandner and Block, 2011; Useche, 2014; Bernstein, 2015; Paleari et al., 2014; Block et al., 2015; Cao et al., 2015; Gounopoulos and Pham, 2018) who empirically examine the relationship between innovation, entrepreneurial firms and business outcomes. We update their work using a comprehensive sample of new listings and offer new evidence on the associated relationships between TM creation and activity the IPO initial aftermarket return and especially survivorship in the long term. Chemmanur et al. (2018) on a recent study investigates the role of trademarks in the financing, valuation, and performance of Venture Backed IPOs. We extend their work by exploring TMs in the entire sample of IPOs. In addition, we investigate the longevity of those firms and show that firms going public with TMs may be indicating their innovative character using underpricing as a signal of their prospects. The economic intuition suggests that the quality signal transmitted via the underpricing of the IPO will be received as endorsement by financial intermediates and the market to mitigate adverse selection costs of funding in the post IPO period.

The rest of the chapter is organized as follows. Section 2.2 discusses the literature and our theoretical predictions. Section 2.3 outlines our econometric specification. We describe our data construction and sample in Section 2.4. We present our results and robustness tests in Section 2.5. Finally, Section 2.6 concludes the chapter.

## 2.2 Conceptual Framework

### 2.2.1 Trademark Basics

A trademark is a type of Intellectual Property (IP) that is employed by firm's to differentiate their products and services, reduce search costs and establish consumer loyalty. It can, among others, take the form of word, phrase, symbol or combination thereof. A firm that wishes to obtain a TM in the US needs to file its application at the USPTO and therefore undergo an examination process. Investment in TMs is regularly treated as an operational expense under SGA and under certain circumstances as intangible assets.

TMs are the most widely used type of IP protection as it is available both to small and large firms at a relatively low cost (Graham et al., 2013; Hall et al., 2014) while, according to the US National Foundation (2012) , constitute one of the most important IP mechanisms for innovative and RD intensive firms. Further, firms spend considerable effort and money developing their own TMs as part of their marketing strategy (Graevenitz, 2013) and their importance rests on the achieved degree of company identifiability and commercialization.

Given the importance of TMs for firms, the related scholarly literature has increased substantially over the last twenty years. One of the first strands of this research was to examine the indication of their role and how closely linked to the introduction of new products. In other words, they are likely to be associated with entry or improved versions of established products. OECD classifies initial product development as an indication of innovation (Faurel et al., 2017; Mendonça et al., 2004) presents corroborative evidence. Amara et al. (2008) also provide support towards this argument; employing a sample of 2625 Canadian firms, they conclude that TMs are complementary to patents. Patents are the type of IP that has been most closely linked to innovation activity (Pakes. and Griliches, 1980; Trajtenberg, 1990). Therefore, this strong association between patents and TMs is the cornerstone of innovation activity. Finally, Meindert Flikkema (2014) also provide support to the above discussion by showing that 60% of Benelux TMs are associated with more innovation.

A major related strand of this literature has examined whether TMs contribute to the firm's market value. For a sample of Australian firms, (Bosworth and Rogers, 2001) find an insignificant relationship between TMs and market value. While in a later study, for UK firms, Greenhalgh and Rogers (2007) conclude that TMs contribute to firm's market value; the interpretation they offer correlates TMs with firm's innovation. Sandner and Block (2011); Fosfuri et al. (2008); Krasnikov et al. (2009); Block et al. (2014); Millot (2012); Thoma (2015) in a similar spirit, examine samples of firms from different periods and countries and find a positive effect of TMs on firm value.

Several other studies have examined the contribution of TMs in various economic and business activities. Block et al. (2014) and Zhou et al. (2016) show that TMs are associated to new firms' access to venture capital and to assessing venture capital valuation. Seethamraju (2003) find that for a sample of US firms, TMs are associated with increased sales while Griffiths et al. (2011) find that TMs contribute to firm's profits.

While the above studies have expanded our understanding of the role of TMs to economic activity and value, until now there is no empirical study that examines the role of TMs to a firm's IPO underpricing. In the following section, we discuss on the possible roles and interactions of TMs with underpricing and possible other firm dimensions.

### 2.2.2 Trademarks and IPO Underpricing

An IPO is a mechanism which ranks high in every companies strategy as far as providing identifiability, serving to attract better executives and input providers, as well as more loyal customers. IPOs then can be reckoned, to perform a chorus role in further establishing the company image to the public conscience. TMs can help towards this direction as in collaboration with an IPO can broaden the image of the company and solidify awareness about the firm, enhancing the creation of a brand name. However, the direct role of TMs in IPO underpricing is more nuanced. Asymmetric information theories can point towards several corollaries regarding IPO underpricing, relevant to the information emanating from the existence of TMs. One the one hand, firms for which 'relevant' value information is more widely spread among investors should experience less underpricing (Rock, 1986; Michaely and Shaw, 1994; Luo, 2008). This effect is enhanced if TMs tend to reduce the asymmetry between issuers and investors as well as informed and uninformed investors. In this order, issuers with higher exposure to intangibility need the cash to mitigate financial risk. In a recursive argument, TMs tend to reduce information asymmetries and thus underpricing so that enough cash is generated to hedge their position in the Balance sheet structure. Moreover, firms with TMs may seek a more credible specification of their value by underwriters since the intangibility of their assets prescribes for a stronger need for cash as collateral and liquidity requirement.

On the other hand, the higher the uncertainty about the value of the firm the higher is the expected underpricing (Ritter, 1984; Beatty and Ritter, 1986; Beatty and Welch, 1996; Benveniste and Jard, 2003; Ljungqvist and Wilhelm, 2003; Schenone, 2004; Heeley et al., 2007). TMs as intangibles will tend to increase the ex-ante uncertainty about the true value of the firm. Chemmanur et al. (2018) argue that TMs play a role as asymmetric information dissipater in the setting of the offer price, which is an expectation from the underwriter's

point of view of the first day closing price. It reduces the discount imposed by underwriter as it predicts superior post IPO performance.

Further, IPO underpricing theory is able to provide another argument in support of higher underpricing in the presence of TMs. Namely, underpricing as a means of signaling firm quality. When issuers have better information about their true value compared to investors, they have an incentive to accept higher underpricing in order to separate themselves from lower quality firms and succeed to raise funds in more privileged terms in later equity issues (SEOs). Firms with TMs have an insiders view of the true value of these assets especially when TMs do not appear on the balance sheet (Ibbotson and Jaffe, 1975; Grinblatt and Hwang, 1989; Welch, 1989; Luo, 2008; Francis et al., 2010). Underwriters wish to keep all stakeholders satisfied, especially fund managers. They can count on the firms identifiability and a possible unsatisfied clientele for IPO shares, pushing first day closing price up. Finally, fund managers participating in the book building process, have an incentive to keep the offer price low for firms difficult to price such as firms with TMs (Welch, 1992; Chowdhry and Nanda, 1996; Asquith et al., 1998; Krigman et al., 1999; Ljungqvist and Wilhelm, 2003)

From the above, one can argue that the intangibility aspect of TMs and the possibility that their value is not explicitly accounted for on the Balance Sheet, even at cost, creates a setting where contradicting theoretical arguments predict a different relationship between TMs and IPO underpricing. For the remainder of our chapter we pursue empirically this question to infer which of the above arguments is more prevalent.

Finally, we posit that the strength of each of the above arguments is likely to differ across industries. From a simple point of view, it can be reasonably assumed that some consumers are investors and all investors are consumers. Hence, a firm with TMs is a better recognizable entity compared to its counterparts lacking TMs, all else equal. However, this is more likely to occur when TMs are associated with tangible products compared to intangible i.e. services. Therefore, we argue that TMs associated with firms in product-based industries can reduce the asymmetric information between owners and investors and therefore underpricing. On the contrary, TMs associated with services are not likely to reduce any ex ante information asymmetry and therefore increase IPO underpricing.

### 2.2.3 Trademarks and Firm Longevity

We examine the impact of trademark activity in firm's longevity following the competing explanations of underpricing, emanating from the asymmetric information literature. In this way we can put alternative propositions, within this strand of the literature, to test and fill an important gap in the relevant empirical research.

A large number of studies indicate that innovation plays important role in business survival, (Hall, 1987; Ericson and Pakes, 1995; Prez et al., 2004; Cefis, 2005; Geroski, 1995; Audretsch, 1995; Hielke Buddelmeyer and Wooden, 2010; Tsvetkova and Macy, 2014; Ugur et al., 2016; rim Ha et al., 2016). Although these studies have found a clear positive effect between innovation and firms longevity there are also several studies that indicate insignificant or conflicting relationship (Li et al., 2010), using data on 870 software companies, relate RD capital expenditures on labs and equipment with lower hazard rates. Mahmood (2000) , using a US sample of startup companies, finds that RD intensity have insignificant effects in 11 out of 17 estimations based on a log logistic model. The above studies point to the growing need to filter innovation, not just by the evolution of the product itself but also by the development around it, which makes it more recognizable and valuable to the customers. This incremental type of innovation can be measured fairly well through the company's TM activity.

TM activity as it is related to firm value and longevity presents an extremely valuable opportunity to analyze underpricing in the context of the aforementioned asymmetric information and signaling theories. These theoretical arguments based mostly on the winners curse and information revelation theories could be juxtaposed to the signaling theories following the work of (R.Faulhaber, 1989; Grinblatt and Hwang, 1989) and (Welch, 1989) who argue that issuers incur costs (underpricing) to reveal their quality and benefit from future SEOs when the quality would have been revealed. Firm longevity related to the investment in trademarks (additional cost to the firm) could provide a positive argument towards the superiority of the signaling approach vis-a-vis the contending theories. IPOs do reveal all those firms' competitive advantage in the medium to long run. A period long enough, to compensate for the incurred costs, rendering underpricing the outcome of an optimizing behavior on the part of the issuer and the underwriter. Indeed, the longer the anticipated life of an issuing firm the higher the optimal underpricing that can be accommodated.

## 2.3 Econometric Setup

To examine our empirical question, we first estimate the following equation:

$$\ln(Underpricing_i + 1) = a_0 + a_1 TMGranted_i + Controls_i + e_i \tag{2.1}$$

Where Underpricing equals to the difference between the closing price and offer price divided by offer price.

TMGranted is our variable of interest and takes the value of 1 if firm i has at least one trademark granted by the year before the IPO and 0 otherwise; for robustness, in alternative specification, we instead consider TMFiled which takes the value of 1 if firm i has filed for at least one trademark by the year before the IPO and 0 otherwise.

If $a_1 > 0$ then based on the arguments in the previous section, information asymmetry dominates any visibility caused by TMs. However, if $a_1 < 0$, then TM's role as mechanism of identifiability dominates any asymmetric information effects that are caused by firm's TM activity.

The Controls include control variables traditional to the IPO underpricing literature. FirmAge, which is the number of years the firm is operating, has been employed in the literature as a proxy of risk; i.e. younger firms are more likely to be risky investments (Ritter, 1984, 1991; Carter et al., 1998)

IPO Proceeds is the amount in millions of US dollars; a large value of Proceeds could imply greater visibility of the firm to investors and therefore result in lower underpricing.

Earnings takes the value of 1 if the year prior to the IPO the firm discloses earnings and 0 otherwise. The literature has not concluded to a clear sign of this variable to IPO underpricing as profitability in one year may not be a credible indicator to long-term post-IPO performance especially in light of exogenous shocks (Anderson, Denis and Trueman, J.W.H., 2000).

Leverage is the ratio of total liabilities over total assets before the IPO. Studies have shown that firms relying on debt to be less inclined to "allow" a high underpricing (Jensen, 1986).

UnderwriterRank is collected by (Loughran and Ritter, 2004) and takes the value of 1 if the underwriter is prestigious and 0 otherwise. Carter and Manaster (1990) show that IPOs with prestigious underwriters are more likely to result to underpricing. This finding's intuition is that established underwriters are less likely to be involved with IPOs of questionable quality.

Overhang is calculated as the ratio of shares retained by pre-IPO shareholders to the equity given up in IPO. A large value of Overhang could imply that underpricing bears no costs to the pre-IPO shareholders (Bradley and Jordan, 2002)

We also include Revisions which is the change of the IPO offer price from the midpoint of the initial filing price range. Any change is likely to indicate new information revealed to the underwriter by the time of listing Hanley (1993); Goldreich (2002)

We further include year dummies and various industry-related dummies. Specifically, Internet takes the value of 1 if the firm is classified as an internet firm and 0 otherwise. Technology takes the value of 1 if the firm belongs to SIC codes that technology intensive industries (for the detailed classification see Table A1 of the Appendix). Nasdaq takes the

value of 1 if the firm's IPO was in NASDAQ and 0 otherwise. Further, we include dummies that take into account the first-digit of the SIC industry each firm belongs to.

Our baseline estimation is Ordinary Least Squares (OLS). While we do include a rich set of controls, there are may still be unobservables that are correlated with TM activity. To this end, an alternative econometric strategy would be to obtain an instrument that influences trademark activity but not directly influences the firm's IPO underpricing. This task is daunting given that TM activity and the firm's all other activities are closely intertwined. We follow Cao et al. (2015) and instrument with the industry's average Market to book ratio. We should stress two important points. First, given that we need to have a considerable number of industry observations to construct this variable, we are forced to give up observations and subsequently end up with a smaller sample of firms for this part of the analysis. Second, and more importantly, this instrument is not likely to be ideal given the nature of the TM activity.

Due to the latter point, we also perform propensity score matching in the spirit of Rosenbaum and Rubin (1983) following the algorithms set by (Becker and Ichino, 2002). The propensity score method in essence matches the firms that have at least one TM prior to IPO (i.e. treated firms) with a firm, or firms, that do not have a TM (i.e. control firms) based on the rest of the control variables in the specification. To provide robustness that our results are not driven by different matching methods, we perform the three most common ones (Robins et al., 1994) that is, through means of the nearest neighbor, kernel and stratification.

To examine whether TM activity contributes differently to each group of industry (product-based vs. service-based), we distinguish firms by their first digit SIC classification. We assign firms to the manufacturing/product sectors as those that belong in the Agriculture, Forestry and Fishing, Mining, Construction, and general Manufacturing and those to the service sectors that belong in the Transportation, Communications, Electric, Gas and Sanitary service, Retail Trade, Finance, Insurance and Real Estate, general Services and Public Administration. We then re-estimate the regressions by distinguishing between the two groups and include interaction terms to examine any statistical significance between the two groups.

## 2.4 Data

### 2.4.1 Data Construction

We constructed our sample based on the population of US IPOs announced between 1997 and 2016 from the Securities Data Company (SDC). We obtain accounting and aftermarket data from Compustat and the Center for Research in Security prices (CRSP). We also collected

TM data from Orbis. Orbis collects and maintains TM data for the firms in its dataset. Recent studies have employed TM data from Orbis; for instance, (Sandner and Block, 2011) use the data to compile the TM stock for listed firms to examine their contribution to market value. We collect bibliographic information on TMs from the Office of the Chief Economist at the USPTO (Graham et al., 2013). To cross-verify the integrity of the Orbis database we also hand-collect the information on TMs from the firm's prospectuses filed for their IPO.

In line with the existing literature (Loughran, 2002) we eliminate IPOs with offer price less than 4 dollars per share or Proceeds of less than 5 million USD. Further we disregarded IPOs that correspond to American depository receipt (ADR), leverage buyout (LBO) or real estate investment (REIT). We further exclude limited partnerships, unit offer, financial institutions, close-and funds and corporate spin-offs. We also exclude IPOs with underpricing larger than the 95th percentile. Our final sample includes 2,275 US listed firms.

### 2.4.2 Data Description

Table 2.1 displays the summary statistics of our dependent and independent variables. From the outset we see that most of firms had not filed for a TM until the IPO; only 24% of firms had filed for a TM prior to the IPO's date. Given that this may seem counterintuitive, we further examined the firm's prospectuses and found no reference to TM activity. Moreover, previous studies do find for a large share of listed firms to have no TM activity. For instance, in their sample, (Block et al., 2014) find that approximately 40% of VC-funded firms had not filed for a TM.

Moving on to our dependent variable, the average firm experienced a 14.08% underpricing; more importantly firms with TMs have on average 6.8 percentage units more than firms without TMs. This first comparison yields the first insight that the presence of TMs is associated with higher underpricing compared to firms without. It provides support in favor of asymmetric information and any signal that the firm wishes to transcend to the market.

In Panel B we examine the independent variables used in the econometric estimations. Our focus is on the comparison between firms with and without TMs. Of the ten variables, three are statistically different at the 1% while two more at the 10% level. Intuitively, Revisions are higher for the firms with TMs as they are likely to be revised upwards more than for the firms without. Further, while the difference is borderline significant, firms with TMs are less likely to have a profitable year prior to IPO ; a result that corroborates the risky aspect of TM-related activity as such firms pursue new product and higher investment on visibility.

## Table 2.1: Summary Statistics

| | Full Sample (N= 2275) | | | | IPOs with TMs (N = 533) | | | | IPOs without TMs (N=1742) | | | | P-value of T -Diff |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Min | Max | Mean | Median | Min | Max | Mean | Median | Min | Max | |
| | s.d. | | | | s.d. | | | | s.d. | | | | |
| Panel A IPO underpricing | | | | | | | | | | | | | |
| *ln(Underpricing+1)* | 14.08 | 6.95 | -97 | 114.2 | 19.3 | 14.71 | -91 | 109.4 | 12.49 | 5.14 | -97 | 114.2 | 00.0 |
| | 23.49 | | | | 25.1 | | | | 22.75 | | | | |
| Panel B IPO characteristics | | | | | | | | | | | | | |
| *Proceeds* | 184.16 | 80.00 | 5.10 | 21767.22 | 212.11 | 78.00 | 6.00 | 16006,88 | 175.60 | 81.225 | 5.10 | 21767,22 | 0.29 |
| | 708.44 | | | | 1009,55 | | | | 586.34 | | | | |
| *Revisions* | -1.07 | 0.00 | -83.33 | 56.25 | -0.18 | 0.00 | -69.23 | 56.25 | -1.34 | 0.00 | -83.33 | 40 | 0.08 |
| | 13.45 | | | | 14.08 | | | | 13.24 | | | | |
| *Earnings* | 0.48 | 0.00 | 0.00 | 1.00 | 0.45 | 0.00 | 0.00 | 1 | 0.49 | 0.00 | 0.00 | 1.00 | 0.09 |
| | 0.50 | | | | 0.49 | | | | 0.50 | | | | |
| *Leverage* | 0.63 | 0.36 | 0.00 | 81.50 | 0.66 | 0.33 | 0.00 | 26.22 | 0.63 | 0.38 | 0.00 | 81.50 | 0.77 |
| | 2.21 | | | | 1.50 | | | | 2.37 | | | | |
| *FirmAge* | 17.31 | 9.00 | 0.00 | 224.00 | 17.05 | 10.00 | 0.00 | 158.00 | 17.40 | 8.00 | 0.00 | 224.00 | 0.77 |
| | 24.34 | | | | 21.03 | | | | 25.27 | | | | |
| *UnderwriterRank* | 0.52 | 1.00 | 0.00 | 1.00 | 0.60 | 1.00 | 0.00 | 1.00 | 0.49 | 0.00 | 0.00 | 1.00 | 0.00 |
| | 0.49 | | | | 0.48 | | | | 0.50 | | | | |
| *Internet* | 0.84 | 0.00 | 0.00 | 1.00 | 0.08 | 0.00 | 0.00 | 1.00 | 0.08 | 0.00 | 0.00 | 1.00 | 0.86 |
| | 0.27 | | | | 0.27 | | | | 0.27 | | | | |
| *Technology* | 0.31 | 0.00 | 0.00 | 1.00 | 0.47 | 0.00 | 0.00 | 1.00 | 0.27 | 0.00 | 0.00 | 1.00 | 0.00 |
| | 0.46 | | | | 0.49 | | | | 0.44 | | | | |
| *Nasdaq* | 0.66 | 1.00 | 0.00 | 1.00 | 0.75 | 1.00 | 0.00 | 1.00 | 0.63 | 1.00 | 0.00 | 1.00 | 0.00 |
| | 0.47 | | | | 0.43 | | | | 0.48 | | | | |
| *Overhang* | 4.30 | 2.82 | 0.00 | 88.63 | 4.55 | 3.27 | 0.00 | 88.63 | 4.22 | 2.68 | 0.00 | 76.37 | 0.31 |
| | 6.66 | | | | 6.36 | | | | 6.75 | | | | |

Note: This table reports descriptive statistics for a sample of 2,275 U.S. IPOs announced from 1 January, 1997 to 30 Nov, 2016 along with the sub-samples of IPOs with and without TMs activity. All IPOs come from the Securities Data Company (SDC) database. The statistics provided include the mean, median, minimum, maximum and standard deviation for the dependent variables and all control variables used in the subsequent regressions. The presentation of each variable concludes with a test for difference in the sub-sample means. Panel A describes our main measures of IPO pricing, i.e. underpricing and revisions. Panel B describes the IPO firm characteristics which we control for in our analysis. Share price data is from CRSP; accounting data is from Compustat. All variables are defined in Appendix A.

Firms with TMs are also more likely to have a prestigious underwriter and also more likely to be classified as technology firm and listed in NASDAQ. Since these differences are notable, we include them in the econometric specifications to flesh out the role of TMs in underpricing. More importantly however, from comparing the Proceeds and Leverage, the two groups appear to be of similar size and of similar leverage. Therefore, the likelihood of filing for TM is not likely to depend on size or the financial fundamentals of the firm.

To alleviate any concerns about multicollinearity, we display the pairwise correlations of all the variables used in the baseline specification in Table 2.2

Table 2.2: Pairwise Correlations

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Underpricing* | 1.00 | | | | | | | | | | | |
| *TMGranted* | 0.12 | 1.00 | | | | | | | | | | |
| *FirmAge* | -0.07 | -0.01 | 1.00 | | | | | | | | | |
| *Proceeds* | -0.01 | 0.02 | 0.13 | 1.00 | | | | | | | | |
| *Earnings* | -0.04 | -0.04 | 0.10 | 0.04 | 1.00 | | | | | | | |
| *UnderwriterRank* | 0.07 | 0.09 | 0.10 | 0.16 | 0.02 | 1.00 | | | | | | |
| *Revisions* | 0.42 | 0.04 | -0.05 | 0.04 | 0.04 | 0.10 | 1.00 | | | | | |
| *Overhang* | 0.11 | 0.02 | -0.05 | -0.01 | -0.04 | 0.10 | 0.09 | 1.00 | | | | |
| *Leverage* | -0.04 | 0.01 | -0.01 | -0.02 | 0.01 | -0.03 | -0.06 | -0.03 | 1.00 | | | |
| *Nasdaq* | 0.10 | 0.11 | -0.22 | -0.16 | -0.15 | -0.33 | 0.00 | 0.00 | 0.02 | 1.00 | | |
| *Technology* | 0.19 | 0.18 | -0.17 | -0.02 | -0.10 | 0.03 | 0.13 | 0.11 | -0.04 | 0.19 | 1.00 | |
| *Internet* | 0.15 | 0.00 | -0.14 | 0.05 | -0.07 | 0.00 | 0.12 | 0.08 | -0.01 | 0.12 | 0.23 | 1 |

Note: This table reports pairwise correlations of variables used in the study. The sample includes 2,275 U.S. IPOs announced between 1997 and 2016. IPO deals are retrieved from the Securities Data Company (SDC) Database with aftermarket and accounting data obtained from CRSP and Compustat databases, respectively. TM data comes from the Orbis database and from the United States Patent and Trademark Office (USPTO). All variables are defined in Appendix A.

As it is evident no independent variable has a considerable positive or negative correlation with any other variable. Thus, from this analysis there is no cause for concern.

Table 2.3 presents the overall IPO distribution by issue year and industry for survived and failed firms.

Panel A presents a sample overview. It also reports subsamples with the listed and delisted IPOs. A company is considered survived as long as it is continually traded for a 5-year period following the IPO and accordingly failed when it becomes delisted due to any reason in this given period. Our initial sample consists of 2275 firms. From these, at the final date of our sample (December 31, 2016) 939 remain listed and 1336 have been delisted. For the 5-year period after the IPO to be satisfied for our survival consideration we stop including IPOs as of December 31, 2011 so that this subsample consists from 1676 firms. Approximately 57,9% of these firms have survived and 42.1 % have failed. Panel B reports the sample distribution of surviving and failed firms over the period 1997-2011 by issue year. The percentage of surviving companies is growing over the years. For instance, the survival rate of firms that go public with issue year 1997 is on average 54,1%. In contrast the percentage of surviving companies with IPO year 2011 appears to have increased to 70,1%. Additionally,

Table 2.3: IPO Distribution by Issue Year and Industry

Panel A: Distribution of IPOs, 1997-2016

| | From the IPO date to November 2016 | | From the IPO date to five years after the offering | |
|---|---|---|---|---|
| | *N* | % | *N* | % |
| Failed | 1,336 | 58,7 | 706 | 42.1 |
| Survived | 939 | 41.3 | 970 | 57.9 |
| Total | 2275 | 100.00 | 1,676 | 100.00 |

Panel B: Distribution by issue year

| Year | All IPOs | Failed | | Survived | |
|---|---|---|---|---|---|
| | *N* | *N* | % | *N* | % |
| 1997 | 198 | 91 | 45.9 | 107 | 54.1 |
| 1998 | 141 | 69 | 48.9 | 72 | 51.1 |
| 1999 | 202 | 108 | 53.5 | 94 | 46.5 |
| 2000 | 168 | 81 | 48.2 | 87 | 51.8 |
| 2001 | 44 | 14 | 31.8 | 30 | 68.2 |
| 2002 | 45 | 17 | 37.8 | 28 | 62.2 |
| 2003 | 51 | 22 | 43.1 | 29 | 56.9 |
| 2004 | 150 | 53 | 35.3 | 97 | 64.7 |
| 2005 | 120 | 40 | 33.3 | 80 | 66.7 |
| 2006 | 148 | 52 | 35.1 | 96 | 64.9 |
| 2007 | 146 | 57 | 39 | 89 | 61 |
| 2008 | 19 | 6 | 31.6 | 13 | 68.4 |
| 2009 | 40 | 16 | 40 | 24 | 60.00 |
| 2010 | 111 | 32 | 28.9 | 79 | 71.1 |
| 2011 | 87 | 26 | 29.9 | 61 | 70.1 |
| 2012 | 98 | - | - | - | - |
| 2013 | 168 | - | - | - | - |
| 2014 | 216 | - | - | - | - |
| 2015 | 108 | - | - | - | - |
| 2016 | 15 | - | - | - | - |
| Total | 2275 | - | - | - | - |

Panel C: Distribution by industry

| Industry | From the IPO date to November (1997-2016) | | | | | | From the IPO date to five years after the offering (1997-2011) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All IPOs | | Failed | | Survived | | All IPOs | | Failed | | Survived | |
| | *N* | % | *N* | % | *N* | % | *N* | % | *N* | % | *N* | % |
| Service | 1,414 | 62,1 | 773 | 34.00 | 641 | 28.2 | 1,076 | 64.2 | 473 | 28.2 | 603 | 36.00 |
| Manufacturing | 861 | 37,9 | 470 | 20.6 | 391 | 17.2 | 600 | 35.8 | 233 | 13.9 | 367 | 21.9 |
| Total | 2275 | 100.00 | 1243 | 54.6 | 1032 | 45.4 | 1,676 | 100 | 706 | 42.1 | 970 | 57.9 |

Note: This table reports pairwise correlations of variables used in the study. The sample includes 2,275 U.S. IPOs announced between 1997 and 2016. IPO deals are retrieved from the Securities Data Company (SDC) Database with aftermarket and accounting data obtained from CRSP and Compustat databases, respectively. TM data comes from the Orbis database and from the United States Patent and Trademark Office (USPTO). All variables are defined in Appendix A.

the IPO activity has diminished over the crisis period 2008-2009.Panel C provides summary statistics by industry. From the 2275 firms, 1414 operate in the service sector and 861 in manufacturing. Notably, at the end of 2016 on average 28,2% of the companies that belong to the service sector where been delisted. Respectively, in the manufacturing sector the percentage is limited to 17.2%. In addition, from the 57.9% of the firms that have survived, 36% are operating in the service sector and 21.9% in Manufacturing.

Table 2.4 presents the distribution of survived firms with TMGranted and those without TMs for our sample constructed for the period 1997-2011. It also provides the cumulative percentage of failed firms by issue year and by sector. For instance, we show in panel A that for non-TM firms the cumulative percentage of failure is 8.9% during the first year, 25.7% for the year following IPO, 43.1% and 55.6% for the third- and fourth-year end 61% for the fifth year. On the contrary for TMGranted firms the cumulative percentages of failure

are much smaller correspondingly, 3%, 3%, 6%,13,3% and 16,6%. Notably, firms with trademark activity have by far lower failure rates. Panel B reports information for the sample of 1676 companies for the five-year period from the day of the IPO. The cumulative rates of failure for firms with TMGranted in the service sector are 2%, 0,6%, 1,4%, 2,2% and 2,5 compared to 5,1%, 12,7%, 18,3%, 22,8%, and 25,7% for non-TM firms. Similarly, in the manufacturing sector non-TM firms have higher failure rates equal with 2,1%, 4,8%, 7,6%, 9,7%, 11,6% compared to companies with TMGranted who have 2%, 0,6%, 1,1%, 1,6%, 2,3% for the same time period of five years following the IPO. On average, in the service sector the distance in the failure rate between non-TM and TMGranted firms is higher compare to the manufacturing sector. Overall our results suggest that IPO firms with granted trademarks before the issue date exhibit better survivability compared to the companies with non-trademark activity.

In order to shed more light to the post IPO performance for TM active firms compared to the non-active ones we provide in Table 5 evidence that firms with trademarks issue new shares in SEOs with better terms, i.e. lower underpricing (see last column of the table).

Table 2.5 demonstrates univariate analyses of SEO for both groups of firms those with TMGranted and those with no TMs. From our initial sample, 998 firms use SEOs to raise new equity. TM active firms exhibit on average lower volume of primary and total proceeds per firm which possibly indicates that TM active firms have better profitability and hence use less equity financing.

Table 2.4: Survival Distribution of IPO Firms Which have at Least one Granted Trademark and Those With no Granted Trademark

Panel A: Survival distribution by issue year (1997-2011)

| Year | TM Granted | Number and percentage of IPO firms | | Cumulative number and percentage of failed firms | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Within 1 year | | Within 2 years | | Within 3 years | | Within 4 years | | Within 5 years | |
| | | *N* | % | *N* | % | *N* | % | *N* | % | *N* | % | *N* | % |
| 1997 | Yes | 30 | 48.60 | 1 | 3 | 1 | 3 | 2 | 6 | 4 | 13.3 | 5 | 16.6 |
| | No | 167 | 51.40 | 15 | 8.9 | 43 | 25.7 | 72 | 43.1 | 93 | 55.6 | 102 | 61 |
| 1998 | Yes | 20 | 48.60 | 0 | 0.00 | 2 | 10 | 2 | 10 | 3 | 15 | 3 | 15 |
| | No | 125 | 51.40 | 17 | 13.6 | 36 | 28.8 | 54 | 43.2 | 59 | 47.2 | 68 | 54.4 |
| 1999 | Yes | 40 | 48.60 | 3 | 7.5 | 7 | 17.5 | 8 | 20 | 9 | 22.5 | 9 | 22.5 |
| | No | 161 | 51.40 | 29 | 18 | 63 | 39.1 | 81 | 50.3 | 89 | 55.2 | 98 | 60.8 |
| 2000 | Yes | 37 | 36.80 | 0 | 0.00 | 3 | 8.1 | 6 | 16.2 | 9 | 24.3 | 11 | 29.7 |
| | No | 130 | 63.20 | 21 | 16.1 | 43 | 33 | 57 | 43.8 | 62 | 47.6 | 69 | 53 |
| 2001 | Yes | 11 | 26.67 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| | No | 34 | 73.33 | 2 | 5.8 | 6 | 17.6 | 7 | 20.5 | 15 | 44.1 | 15 | 44.1 |
| 2002 | Yes | 10 | 23.33 | 0 | 0.00 | 1 | 1 | 2 | 20 | 2 | 20 | 3 | 30 |
| | No | 35 | 76.67 | 4 | 11.4 | 6 | 17.1 | 10 | 28.5 | 12 | 34.2 | 14 | 40 |
| 2003 | Yes | 15 | 56.41 | 0 | 0.00 | 0 | 0.00 | 2 | 16.6 | 3 | 20 | 5 | 33.3 |
| | No | 36 | 43.59 | 3 | 8.3 | 8 | 22.2 | 8 | 22.2 | 12 | 33.3 | 17 | 47.2 |
| 2004 | Yes | 47 | 61.05 | 1 | 2.1 | 2 | 4.2 | 5 | 10.6 | 8 | 17 | 9 | 19.1 |
| | No | 104 | 38.95 | 3 | 2.8 | 9 | 8.6 | 26 | 25 | 40 | 38.4 | 45 | 43.2 |
| 2005 | Yes | 28 | 52.11 | 1 | 3.5 | 1 | 3.5 | 3 | 10.7 | 5 | 17.8 | 8 | 28.5 |
| | No | 93 | 47.89 | 5 | 5.3 | 14 | 15 | 22 | 23.6 | 27 | 29 | 33 | 35.4 |
| 2006 | Yes | 27 | 63.86 | 0 | 0 | 3 | 11.1 | 3 | 11.1 | 6 | 22.2 | 7 | 25.9 |
| | No | 122 | 36.14 | 5 | 4 | 18 | 14.7 | 28 | 22.9 | 40 | 32.7 | 46 | 37.7 |
| 2007 | Yes | 32 | 57.14 | 0 | 0.00 | 1 | 3.1 | 4 | 12.5 | 6 | 18.7 | 10 | 31.2 |
| | No | 113 | 42.86 | 8 | 7 | 18 | 15.9 | 28 | 24.7 | 39 | 34.5 | 47 | 41.5 |
| 2008 | Yes | 5 | 57.14 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 1 | 20 |
| | No | 14 | 42.86 | 1 | 7.1 | 4 | 28.5 | 4 | 28.5 | 4 | 28.5 | 5 | 35.7 |
| 2009 | Yes | 8 | 43.33 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 1 | 12.5 | 1 | 12.5 |
| | No | 32 | 56.67 | 1 | 3.1 | 5 | 15.6 | 9 | 28.1 | 12 | 37.5 | 15 | 46.8 |
| 2010 | Yes | 29 | 43.33 | 0 | 0.00 | 0 | 0.00 | 1 | 3.4 | 2 | 6.8 | 3 | 10.3 |
| | No | 84 | 56.67 | 7 | 8.3 | 11 | 13 | 14 | 16.6 | 25 | 29.7 | 31 | 36.9 |
| 2011 | Yes | 25 | 43.33 | 0 | 0.00 | 1 | 4 | 3 | 12 | 4 | 16 | 5 | 20 |
| | No | 62 | 56.67 | 1 | 1.6 | 9 | 14.5 | 13 | 20.9 | 16 | 25.8 | 21 | 33.8 |
| 1997-2011 | Yes | 364 | 21.7 | 6 | 1.6 | 20 | 5.4 | 41 | 11.2 | 62 | 17 | 80 | 21.9 |
| | No | 1312 | 78.3 | 122 | 9.2 | 293 | 22.3 | 433 | 33 | 545 | 41.5 | 626 | 47.7 |

Panel B: Survival distribution by industry (1997-2011)

| Industry (two-digit SIC code) | TM Granted | Number andpercentage of IPO firms | | Cumulative number and percentage of failed firms | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Within 1 year | | Within 2 years | | Within 3 years | | Within 4 years | | Within 5 years | |
| | | *N* | % | *N* | % | *N* | % | *N* | % | *N* | % | *N* | % |
| Service | Yes | 192 | 11.4 | 3 | 2 | 10 | 0.6 | 23 | 1.4 | 36 | 2.2 | 42 | 2.5 |
| Service | No | 884 | 52.8 | 86 | 5.1 | 213 | 12.7 | 306 | 18.3 | 382 | 22.8 | 431 | 25.7 |
| Manufacturing | Yes | 172 | 10.3 | 3 | 2 | 10 | 0.6 | 18 | 1.1 | 26 | 1.6 | 38 | 2.3 |
| Manufacturing | No | 428 | 25.5 | 36 | 2.1 | 80 | 4.8 | 127 | 7.6 | 163 | 9.7 | 195 | 11.6 |
| Total firms with trademarks | Yes | 364 | 23.4 | 6 | 4 | 20 | 0.12 | 41 | 2.5 | 62 | 3.8 | 80 | 4.8 |
| Total firms without trademarks | No | 1,312 | 76.6 | 122 | 7.2 | 293 | 17.5 | 433 | 25.9 | 545 | 35.2 | 626 | 37.3 |
| Total firms | | 1676 | 100 | 128 | 11.2 | 313 | 17.17 | 474 | 28.4 | 607 | 36.3 | 706 | 42.1 |

Note: The table presents the comparison of the distribution and cumulative failure rates by issue year and industry between the two groups of IPO firms: those with a TMGranted and those who don't. The cumulative number and percentage of failed firms are examined for five years after the offering. N denotes the number of observations

Table 2.5: The Role on TMs on SEO Proceeds and Underpricing

| TM Granted | Number of firms | Number of SEO | SEO/firm | SEO primary proceeds per firm | SEO total proceeds | SEO underpricing |
|---|---|---|---|---|---|---|
| Yes | 293 | 645 | 2.20 | 1.06 | 1.44 | 0.04 |
| No | 705 | 1,728 | 2.45 | 1.33 | 1.55 | 0.23 |
| Total | 998 | 2373 | 2.37 | - | - | - |

The table presents the distribution of univariate analyses of SEO for both groups of firms those with TMGranted and those with no TMs.

## 2.5 Results

### 2.5.1 Trademarks and IPO Underpricing

Table 2.6 displays results for Equation 1. Column 1 estimates Equation 1 via OLS. First of all, all the control variables have the expected signs from previous studies even though they are not always significant. From here, we turn our attention to the role of TM activity.

The coefficient of TMGranted shows that firms with TMs granted prior to their IPO have on average 3.5% more underpricing than firms without. Column 2 instruments TMGranted with the industry's average market to book ratio. Given that due to data unavailability we are unable to construct this instrument for the entire sample these results should be interpret cautiously. The coefficient is even larger than in Column 1. In Columns 3 and 4 we estimate similar regressions to Columns 1 and 2 where instead of TMGranted we consider TMFiled as the treatment dummy. The coefficients here are a little smaller in magnitude while they are still significant. This could indicate that in the case where firms have just begun their TM activity prior to their IPO, the market may not readily evaluate the importance of TM activity for the particular firm.

To further alleviate endogeneity concerns, in Table 2.7 we consider propensity score matching techniques. Columns 1-3 display the results where we consider TMGranted as the treatment dummy; each column considers a different matching method; i.e. means of the nearest neighbor, kernel and stratification respectively (Yu, 2006).

The coefficient of TMGranted ranges from 0.03 to 0.034 and is always significant at the 1% level. These results support the outcome from the OLS analysis in the previous Table and indicate that the role of TMGranted is not likely to be attributed to confounding factors. Columns 4-6 display the results where we consider TMFiled as the treatment dummy in a similar format as the previous three columns. The coefficient of TMFiled ranges from 0.023 to 0.024; further, in the case of the nearest neighbor, the coefficient is not statistically significant at the 10% . These results corroborate those of the previous table where they show

Table 2.6: Role of TM Activity in IPO Underpricing

| Dependent Variable: Underpricing | | | | |
|---|---|---|---|---|
| | (1) | (2) | (5) | (6) |
| TMGranted | 0.035*** | 0.305*** | | |
| | (0.011) | (0.059) | | |
| TMFiled | | | 0.030** | 0.315*** |
| | | | (0.013) | (0.062) |
| FirmAge | 0.002 | -0.004 | 0.003 | -0.004 |
| | (0.004) | (0.004) | (0.004) | (0.004) |
| Proceeds | -0.002 | 0.002 | -0.002 | 0.002 |
| | (0.005) | (0.006) | (0.005) | (0.006) |
| Earnings | 0.006 | -0.000 | 0.006 | 0.001 |
| | (0.010) | (0.010) | (0.010) | (0.010) |
| Venture Capital | 0.038*** | 0.031** | 0.038*** | 0.027** |
| | (0.013) | (0.012) | (0.014) | (0.013) |
| UnderwriterRank | 0.020* | 0.019* | 0.020* | 0.017 |
| | (0.011) | (0.011) | (0.011) | (0.011) |
| Revisions | 0.005*** | 0.005*** | 0.005*** | 0.006*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Overhang | 0.001 | 0.001* | 0.001 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Leverage | -0.000 | -0.002 | -0.000 | -0.002 |
| | (0.001) | (0.002) | (0.001) | (0.002) |
| Nasdaq | 0.006 | 0.018 | 0.006 | 0.019 |
| | (0.010) | (0.012) | (0.010) | (0.012) |
| Technology | -0.012 | 0.004 | -0.012 | 0.004 |
| | (0.018) | (0.015) | (0.018) | (0.015) |
| Internet | 0.025 | 0.014 | 0.025 | 0.012 |
| | (0.021) | (0.026) | (0.021) | (0.027) |
| Observations | 2,275 | 1,425 | 2,275 | 1,425 |
| R-squared | 0.166 | | 0.165 | |
| Year FE | YES | YES | YES | YES |
| Sector FE | YES | YES | | YES |
| OLS | YES | | YES | |
| 2SLS | | YES | | YES |

Columns 1 and 2 include TMGranted as focal independent variable. Column1 is estimated via OLS. Column 2 instruments TMGranted with the industry's average Market-to-Book Ratio. In Columns 3 and 4, for robustness, instead of considering TMGranted we consider the dummy TMFiled. As with the two previous columns, Column 3 is estimated via OLS Column 4 instruments TMFiled with the industry's average Market-to-Book Ratio. In all columns, standard errors reported in parentheses are adjusted for heteroskedasticity. An asterisk indicates significance at the 10% level; two indicate significance at the 5% level; three indicate significance at the 1% level.

Table 2.7: Role of TM Activity in IPO Underpricing. Propensity Score Matching

| | Dependent Variable: Underpricing | | | | | |
|---|---|---|---|---|---|---|
| | Treatment Variable: *TMGranted* | | | Treatment Variable: *TMFiled* | | |
| VARIABLES | (1) | (2) | (3) | (4) | (5) | (6) |
| Nearest neighbor | 0.034*** | | | 0.023 | | |
| | (0.019) | | | (0.016) | | |
| Kernel | | 0.033*** | | | 0.026*** | |
| | | (0.013) | | | (0.013) | |
| Stratification | | | 0.030*** | | | 0.024*** |
| | | | (0.013) | | | (0.013) |
| Observations | 2,275 | 2,275 | 2,275 | 2,275 | 2,275 | 2,275 |

Propensity score techniques. In Columns 1-3 we select the TMGranted dummy based on the control variables of Table 2; that is, FirmAge, Proceeds, Internet, Earnings, Nasdaq, Technology, UnderwriterRank, Revisions, Overhang and Leverage. In Columns 4-6, for robustness, we select TMFiled based on the aforementioned variables. Columns 1 and 4 employ the nearest neighbor method, Columns 2 and 5 the kernel and Columns 3 and 6 the stratification method (Zhao 2004). An asterisk indicates significance at the 10% level; two indicate significance at the 5% level; three indicate significance at the 1% level.

that TMGranted is a stronger predictor of increased underpricing than TMFiled. Nonetheless, if we take cumulatively all the results into consideration, they show that TM activity in general is associated with increased underpricing.

To examine our second conjecture on whether firms with TMs in the service sector have different underpricing compared to firms in the manufacturing sector, we re-estimate Equation 1 in Table 2.8 while distinguishing between service and manufacturing firms.

In Column 1 we consider firms in the service sectors while in Column 2 firms in the manufacturing sectors. TMGranted is associated with a 5.7% increase in underpricing in the case of the service sector while, in the case of the manufacturing sector, TMGranted coefficient is much smaller and statistically insignificant.

To examine whether the coefficient of TMGranted is statistically significant between the two sectors, we take into account the entire sample and include in Equation 1 a Service dummy which takes the value of 1 if the firm belongs in the service sector and 0 otherwise and the interaction Service_x_TMGranted. The interaction term shows that TMGranted increases the underpricing by 5.6% more in the service sector than in the manufacturing sector. This coefficient is significant at the 1% level.

Table 2.8: Role of TM Activity in IPO Underpricing by Industry

| Dependent Variable: Underpricing | | | |
|---|---|---|---|
| VARIABLES | (1) | (2) | (3) |
| TMGranted | 0.057*** | 0.010 | 0.005 |
| | (0.015) | (0.014) | (0.014) |
| TMGranted_x_Service | | | 0.056*** |
| | | | (0.021) |
| Service | | | 0.005 |
| | | | (0.019) |
| FirmAge | 0.007 | -0.006 | 0.002 |
| | (0.006) | (0.006) | (0.004) |
| Proceeds | -0.006 | 0.003 | -0.002 |
| | (0.006) | (0.009) | (0.005) |
| Earnings | 0.014 | -0.008 | 0.006 |
| | (0.014) | (0.014) | (0.010) |
| Venture Capital | 0.044** | 0.017 | 0.037*** |
| | (0.019) | (0.015) | (0.013) |
| underwriter | 0.028* | 0.013 | 0.020* |
| | (0.016) | (0.013) | (0.011) |
| revision | 0.006*** | 0.004*** | 0.005*** |
| | (0.001) | (0.000) | (0.000) |
| overhang | 0.001 | 0.001 | 0.001 |
| | (0.001) | (0.001) | (0.001) |
| Leverage | -0.010* | -0.000 | -0.000 |
| | (0.006) | (0.001) | (0.001) |
| Nasdaq | 0.004 | 0.017 | 0.007 |
| | (0.012) | (0.015) | (0.010) |
| Technology | -0.015 | -0.002 | -0.012 |
| | (0.025) | (0.020) | (0.018) |
| Internet | 0.026 | 0.053 | 0.026 |
| | (0.022) | (0.033) | (0.021) |
| Observations | 1,414 | 861 | 2,275 |
| R-squared | 0.170 | 0.182 | 0.168 |
| Year FE | YES | YES | YES |
| Sector FE | YES | YES | YES |

All Columns are estimated via OLS. Columns 1 considers only firms in the services sectors; Column 2 considers only firms in manufacturing sectors. Column 3 considers the entire sample and includes an interaction of TMGrantedService=TMGranted_x_Service Service takes the value of 1 if the firm belongs in the service sector and 0 otherwise. In all columns, standard errors reported in parentheses are adjusted for heteroskedasticity. An asterisk indicates significance at the 10% level; two indicate significance at the 5% level; three indicate significance at the 1% level

To provide further robustness that the above results hold for both the service and manufacturing sectors, we again perform propensity score matching for the TMGranted variable for both samples. Table 2.9 Columns 1- 3 display the results for the service sectors and Columns 4-6 the results for the manufacturing sector. The results corroborate the findings from the previous Table.

Table 2.9: Propensity Score Matching

| | Dependent Variable: Underpricing Treatment Variable: *TMGranted* | | | | | |
|---|---|---|---|---|---|---|
| | Only Firms in the Service Sectors | | | Only Firms in the Manufacturing Sectors | | |
| METHOD | (1) | (2) | (3) | (4) | (5) | (6) |
| Nearest neighbor | 0.037** | | | -0.004 | | |
| | (0.022) | | | (0.023) | | |
| Kernel | | 0.057*** | | | 0.007 | |
| | | (0.017) | | | (0.017) | |
| Stratification | | | 0.051*** | | | 0.006 |
| | | | (0.018) | | | (0.018) |
| Observations | 1,414 | 1,414 | 1,414 | 861 | 861 | 861 |

Propensity score techniques. In all Columns we select the TMGranted dummy based on the control variables of Table 2; that is, FirmAge, Proceeds, Internet, Earnings, Nasdaq, Technology, UnderwriterRank, Revisions, Overhang and Leverage. In Columns 1-3, we only consider firms in the service sectors; in Columns 4-6 we only consider firms in the manufacturing sectors. In Columns 1 and 4 we employ the nearest neighbor method, Columns 2 and 5 the kernel and Columns 3 and 6 the stratification method (Zhao 2004). An asterisk indicates significance at the 10% level; two indicate significance at the 5% level; three indicate significance at the 1% level.

### 2.5.2 Trademark Activity and Post IPO Performance Depicted by Buy and Hold Abnormal Returns

Prior studies (Block et al., 2014; Useche, 2014; Cao et al., 2015; Chemmanur et al., 2018) show that innovation proxy by R&D and patents provide competitive advantage and therefore associated with better following IPO performance.In this section, in table 2.10 we report the association between innovation around products proxy by trademarks and buy and hold abnormal returns for the first second and third year.In order to construct monthly portfolio buy-and-hold abnormal returns (BHAR) we retrieve stock return data from Center for Research in Security Prices (CRSP) and monthly factors return realization by Kenneth French's data library.We follow Loughran and Ritter (1995) and take time periods of 255, 510 and 765 trading days to construct the BHAR for the first, second and third year following the IPO.

Our results indicate that there is positive association between trademark activity before the IPO and firms buy and hold abnormal returns.

Table 2.10: Role of TM in Post IPO Performance

| | Dependent Variable: Buy and Hold Abnormal Returns | | | | | |
|---|---|---|---|---|---|---|
| | Fama French three factor | | | Carhart four factor model | | |
| Variables | (1) BHAR1 | (2) BHAR2 | (3) BHAR3 | (4) BHAR1 | (5) BHAR2 | (6) BHAR3 |
| TMGranted | 0.046*** | 0.041*** | 0.040*** | 0.046*** | 0.040*** | 0.039** |
| | (0.015) | (0.015) | (0.016) | (0.015) | (0.015) | (0.016) |
| UnderwriterRank | 0.004 | 0.001 | 0.004 | 0.005 | 0.000 | 0.005 |
| | (0.012) | (0.012) | (0.013) | (0.012) | (0.013) | (0.013) |
| Venture Capital | 0.004 | 0.004 | 0.002 | 0.003 | 0.006 | 0.004 |
| | (0.012) | (0.012) | (0.013) | (0.012) | (0.012) | (0.013) |
| Overhang | -0.000 | -0.000 | -0.000 | -0.000 | 0.000 | -0.000 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| FirmAge | -0.005 | -0.006 | -0.004 | -0.006 | -0.007 | -0.005 |
| | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| Proceeds | -0.009 | -0.006 | -0.010 | -0.009 | -0.005 | -0.009 |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.007) |
| Internet | 0.052** | 0.034 | 0.039 | 0.052** | 0.036 | 0.042 |
| | (0.025) | (0.028) | (0.031) | (0.026) | (0.029) | (0.031) |
| Earnings | -0.000 | -0.000 | 0.000 | -0.000 | -0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Nasdaq | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.007 |
| | (0.009) | (0.010) | (0.010) | (0.009) | (0.010) | (0.010) |
| Technology | -0.024 | -0.022 | -0.025 | -0.026 | -0.025 | -0.025 |
| | (0.016) | (0.017) | (0.018) | (0.016) | (0.017) | (0.018) |
| Revisions | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Leverage | -0.004* | -0.003 | -0.003 | -0.004* | -0.002 | -0.003 |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Observations | 2,204 | 1,991 | 1,752 | 2,204 | 1,991 | 1,752 |
| R-squared | 0.056 | 0.057 | 0.054 | 0.054 | 0.055 | 0.054 |
| Year FE | YES | YES | YES | YES | YES | YES |
| Sector FE | YES | YES | YES | YES | YES | YES |

All Columns are estimated via OLS. Columns 1 and 4 considers buy and hold abnormal returns for the first 255 trading days following the IPO; Column 2 and 5 for the 510 and days following IPO and columns 3 and 6 for the 765 days respectively.An asterisk indicates significance at the 10% level; two indicate significance at the 5% level; three indicate significance at the 1% level.

### 2.5.3 Trademark activity, firm longevity and signaling quality

Thus far our baseline results point to the signaling hypothesis of trademark activity. Support for this hypothesis should imply that such firms with TM activity are more likely to perform better in the post-IPO period. This task is taken up in the final section of the results of this chapter. We do collect data on the survivability of our firms in the sample. In particular we collect in years, the time that each firm remains public. We then examine the hazard rate of exiting the stock market following the Cox proportional hazard model Cox (1972) :

$$h_{Exit}(t, TMGranted_i, Controls) = h_0(t)\exp(b_0 + b_1 TMGranted_i + b_2 Controls_i) \quad (2.2)$$

where hExit is the probability that the firm i exits the stock market (gets delisted) at period t (counted in years, from the firm's IPO month), given that it has not been previously delisted. Our interest here is on the coefficient of TMGranted . A negative sign of would show that firms with TM activity prior to IPO, have a lower hazard of being delisted. This would provide support for our aforementioned results.

Starting with the graphical analysis, Figure Nelson-Aalen Cumulative Hazard Estimates and Kaplan-Meier Survival Estimatesares Nelson-Aalen cumulative hazard estimates for firms with TM and w/o TM activity. Firms with TMs have a smaller hazard of exiting throughout the entire time span. Figure 2 compares the Kaplan-Meier survival estimates for both groups and shows similar results. Firms with TM activity are more likely to survive throughout the entire period. For instance, in the 15th year after the IPO, firms with TM activity are roughly 20% more likely to have survived than firms without TM activity.

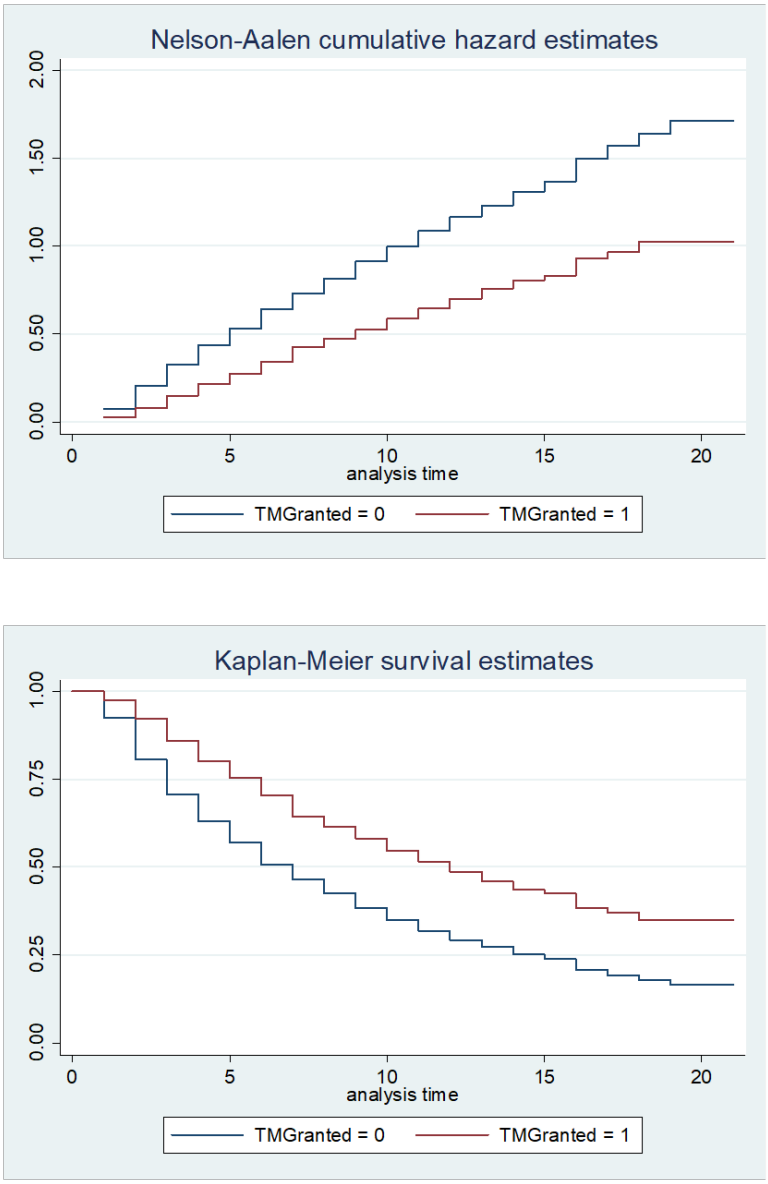


Figure 2.1: Nelson-Aalen Cumulative Hazard Estimates and Kaplan-Meier Survival Estimates

Table 2.11: Estimation of Cox Proportional Hazards Model of Probability of Delisting

| VARIABLES | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| TMGranted | -0.702*** | -0.725*** | -0.707*** | -0.808*** | -0.817*** | -0.848*** |
| | (0.073) | (0.099) | (0.112) | (0.080) | (0.107) | (0.123) |
| FirmAge | -0.049* | -0.091** | -0.011 | -0.063** | -0.115*** | -0.006 |
| | (0.029) | (0.036) | (0.052) | (0.032) | (0.038) | (0.058) |
| Proceeds | -0.030 | -0.017 | -0.029 | -0.011 | 0.001 | 0.005 |
| | (0.035) | (0.042) | (0.066) | (0.037) | (0.046) | (0.070) |
| Venture Capital | 0.172*** | 0.235*** | 0.155 | 0.163** | 0.205** | 0.198 |
| | (0.065) | (0.081) | (0.117) | (0.069) | (0.085) | (0.125) |
| Earnings | -0.103* | -0.023 | -0.250** | -0.103* | -0.014 | -0.274*** |
| | (0.057) | (0.071) | (0.098) | (0.060) | (0.075) | (0.106) |
| UnderwriterRank | -0.156** | -0.227*** | -0.061 | -0.185*** | -0.251*** | -0.096 |
| | (0.063) | (0.078) | (0.108) | (0.066) | (0.081) | (0.117) |
| Revisions | -0.001 | -0.003 | 0.002 | -0.001 | -0.002 | 0.002 |
| | (0.002) | (0.003) | (0.004) | (0.002) | (0.003) | (0.004) |
| Overhang | -0.005 | -0.013** | 0.009* | -0.002 | -0.009* | 0.011* |
| | (0.004) | (0.005) | (0.005) | (0.004) | (0.005) | (0.006) |
| Leverage | -0.002 | 0.069 | -0.007 | 0.000 | 0.077* | -0.004 |
| | (0.011) | (0.043) | (0.015) | (0.012) | (0.046) | (0.016) |
| Nasdaq | 0.177** | 0.279*** | 0.002 | 0.230*** | 0.348*** | 0.031 |
| | (0.074) | (0.091) | (0.136) | (0.080) | (0.100) | (0.145) |
| Technology | 0.235*** | 0.334*** | 0.012 | 0.224** | 0.360*** | -0.125 |
| | (0.084) | (0.104) | (0.144) | (0.090) | (0.109) | (0.153) |
| Internet | 0.066 | 0.017 | 0.005 | 0.134 | 0.069 | -0.047 |
| | (0.109) | (0.113) | (0.244) | (0.116) | (0.121) | (0.246) |
| Observations | 2,263 | 1,405 | 858 | 1,666 | 1,069 | 597 |

The table illustrates the estimation of Cox proportional hazards model of probability of delisting. Column 1 considers all firms. The overall sample is reduced by 12 firms as these firms exited at the year of IPO (t=0). Column 2 considers all firms in the service sector and Column 3 all firms in the manufacturing sector. To avoid any censoring issues in Columns 4-6 we run similar regressions by restricting the sample to firms with IPO year prior to 2012. IPO year fixed effects are included in all specifications. In all columns, standard errors reported in parentheses are adjusted for heteroskedasticity. An asterisk indicates significance at the 10% level; two indicate significance at the 5% level; three indicate significance at the 1% level.

Our econometric analysis is presented in Table 2.11. Column 1 considers all firms. Firms with TM activity prior to IPO have a 1-exp(-0.702)=50% less hazard to get delisted from the US stock market than firms without TMs. This difference is statistically significant at the 1% level. This result is in line with the outcome from table 5 and provides prima facie support for the signaling quality theory of IPO underpricing, since firms which will stay longer in the secondary market will have more opportunities to raise capital by issuing new shares in better terms. The context of issuance in SEO underpricing terms should compensate firms for too much underpricing at the IPO.

We also distinguish between firms in the service and manufacturing industries. Both types of firms with TM activity have a similar difference with their non-TM counterparts.

This shows that presence of TMs is related to a reduction in the hazard of being delisted. To account for any censoring issues, in Columns 4-6, we exclude firms with IPO year on or after 2012. The difference in the hazard rates is now even bigger in favor of firms with TMs while remaining significant at the 1% level.

## 2.6 Conclusion

TMs are an important business tool that firms employ to protect their innovative products and services and increase their visibility in the market. Unsurprisingly, numerous studies have examined their role in a variety of corporate events and finance metrics. However, to this date we do know little about their role in IPOs. A notable exception is the recently published working paper by Chemmanur et al. (2018) where they examine the role of TMs in the probability of exiting via an IPO and post-IPO market valuation. In our study we dwell deeper into the role of TMs as an information mechanism and explicitly examine the relationship between TMs and IPO underpricing;TMs and post IPO performance;TMs and IPO longevity.

Given the intricacies of both TMs, as intangible assets and what they represent in terms of innovation and differentiation, and IPOs, as a funding mechanism and market signal, we borrow arguments from information theory to predict the sign of the relationship. We posit that there are strong arguments both in favor and against increased underpricing. Empirically, we find asymmetric information to dominate any visibility attributed to TMs; as a result, for the average firm the presence of TMs increases underpricing. We further argue that firms with TMs are likely to signal their higher value by tolerating higher underpricing. We find support for this argument as such firms have better post IPO performance, lower hazard of being delisted and raise capital with better terms in later financing.

Our results are also heterogeneous by type industry. Investors and consumers may not be able to readily associate TMs with innovative services as opposed to physical products. Consistent with our theoretical arguments, we find that indeed it is the service sector that primarily drives this positive relationship TMs and IPO underpricing.

# Chapter 3

# Firm's Sustainability and Financial Performance: Evidence from US IPOs

## 3.1 Introduction

Business sustainability is attracting lot of attention. Witnessing the growth of socially responsible investing, where economic as well as social and environmental goals drive investment decisions, more investors and other corporate stakeholders have begun to take a keen interest in the sustainability of businesses. Although analysts may not always speak the language of sustainable development, Wall Street is gradually becoming aware of the importance of measurement and disclosure of non-financial elements of a business (Young, 1996).[1] In response to this demand, more companies have taken to filing corporate sustainability reports (Corteste, 2002).[2]

Yet the word 'sustainability' remains ambiguous and politically charged, particularly within the lexicon of business. When, as is commonly the case, the term is limited to encompass environmental management or social equity, sustainability is often perceived to be at odds and unlinked to business strategy. A sustainable organization is one whose characteristics and actions are designed to lead to a desirable future state for all stakeholders. For investors a desirable future state would include sustained revenue growth over the long term. For the talent market it would include workforce diversity. Regulators and the community at large value environmental stewardship and social responsibility. Consumers seek useful, reliable, price-efficient products and services. From the view of employees of

[1] For example, 50% of oil and gas industry analysts surveyed by Cap Gemini Ernst & Young confirmed that regulatory compliance on environmental issues, community service and lawsuits do indeed affect the value of a company; 68% believe that intangibles related to employees also have significant impact.

[2] The New York Times reports that 487 were published in 2001, up from 194 in 1995 and seven in 1990.

the company itself, a desirable future state includes maintaining viability and profitability as well as managing risk while promoting innovation. Companies that actively manage and respond to a wide range of sustainability indicators are better able to create value for all these stakeholders over the long term. While conventional accounting and financial metrics yield some insight into a company's market value, forward-looking sustainability indicators -from confidence in a company's management to research leadership to the management of environmental liabilities- are becoming more relevant to a business's overall value proposition. As a result, more effort is being paid to codifying the non-financial and intangible aspects of businesses.[3]

There is a number of indicators that the market can gauge firm's sustainability and get important information about firm's value and efficacy, that is, how well a company is run. From the management of corporate liabilities to new market ventures, a sustainable business strategy can improve all segments of corporate activity. Arguably, environmental management, in particular, is a good proxy for gauging overall management capabilities at both the strategic and operational levels. In particular, environmental issues are a robust metaphor because they touch upon all aspects of a business's operations from product design to finance and have implications for a wide range of stakeholders from the government to investors to community citizens (Kiernan, 2000). As managers seek revealing and reliable performance measures of these factors, they can make use of information that their companies already have available ; not only data that they are required to report, but also data that is collected for one purpose and may be used to glean information on other dependent issues. For example, emissions data is required for some regulated toxics, but this same information can also help to establish materials-use goals in a production process. Proactively managing and interpreting these kinds of data will better allow companies to be in control of the measures that matter in their market and industry. Indeed, companies may not have a choice: As data gathering and management systems get more sophisticated, monitoring performance will by necessity be more tightly linked to improving performance. In many ways, the metrics for sustainability and market performance are strategically linked.

Devising innovative ways to meet compliance targets has not only reduced costs; it has also helped steer environmental regulation in a direction beneficial to producers as well as to social and environmental well being. The level of R&D investment in addressing upcoming regulatory requirements can be a good indicator of likely competitive advantage. In addition, any incentives in place for employees, divisions, or business units to develop 'beyond

[3]In France, its *Nouvelles Regulations Economiques* mandates (among other things) reporting on human resources, community and labor standards and in the United Kingdom, the government requires ethical, social and environmental information about occupational pension funds' investment policies.

compliance' processes and technologies would similarly give stakeholders an understanding of whether a company is a leader or a follower when it comes to regulatory involvement.

Furthermore, in commodity industries, product differentiation is particularly difficult, and companies typically compete through operational efficiency and economies of scale. Yet, some companies have differentiated themselves through improved intangibles performance. Because intangibles related to environmental or social responsibility highly interact with customer satisfaction and other stakeholder preferences, improvements in one area can have quite unexpected gains in another.

In addition, recent research and policy literature suggests that there are also good environmental reasons to replace products, which must be manufactured and disposed of, with services. Indeed, most consumers buy products in order to perform a function. If that function can be delivered as a service, there exists the potential that materials intensity for physical goods may decrease, thereby reducing the environmental burden of these transactions.[4]

Proactive investment in sustainable business strategies can decrease other kinds of risk management and lead to better decision making. For example, using materials more efficiently to meet environmental standards can also help to stem product obsolescence, an important strategic concern, and increase loyal customers. Measures related to sustainable risk management include accrued environmental liabilities, fines, warnings and penalties, as well as product take-back programs in compliance with or in addition to regulatory initiatives.

Finally, integrating sustainability considerations into firm's strategic management of social, political and economic factors is a way to expand worldwide. Sustainable operations are an opportunity to avoid or reduce future costs. Early measurement and reporting of leading indicators of sustainability initiatives also helps build better relationships with stakeholders, especially at the local level. For example, firms can prioritize and address multiple issues from water use to climate change to the use of organic cotton and create initiatives to improve their performance along each of these objectives. Adopting a sustainability mind-set can also lead to increased access to capital for expansion initiatives. Although the primary negotiation lever is likely to be focused on price, profit and economics, concern for sustainability could certainly be a differentiator. Some host governments may even demand adherence to sustainable development principles as a price of entry.

The common and intuitive research question that academics have been questioning during the last decade concerns the economic return payoff of the investment when companies adopt corporate social strategies. In other words, several studies point out the need to clarify if

[4]White et al. (1999) describes the 'functional economy' where consumers buy cleaning services instead of washing machines, document services rather than photocopiers, and mobility services rather than cars.

sustainable performance implies better financial performance (Friede, 2015; Revelli and & Viviani, 2015).

A prominent number of studies highlight that information on sustainability indicators is value relevant to explain the positive relation between corporate sustainability and financial performance, in the sense that an enhancement of sustainable practices foster the achievement of better financial performance. As a matter of facts, the voluntary disclosure theory (Cheynel, 2013; Dye, 1985; Verrecchia, 1983) suggests that if companies achieve better sustainability performance, firms may be more prone to show off these results than companies do with lower level of engagement in sustanable practices or even none inclusion of these criteria (Fatemi et al., 2017).

In their conquest for funding their projects, firms may decide to enter the public market for equity funds to supplement borrowed funds and retained earnings. Initial Public Offerings (IPOs) is the first sale of new or existing private shares to new investors. The IPOs constitute an important milestone concerning the ability of an enterprise to become recognizable and to propel its growth by increasing its financing capabilities. It is a strategic and financial entrepreneurial decision with long lasting effects on the future prospects of the firm itself. The literature thus far has not fully investigated the effect of firm's sustainability on IPO performance.

Therefore, the present chapter aims to study the effect of disclosing sustainability information before the IPO on underpricing as well as its post IPO performance. Sustainability has the ability for reducing risk and asymmetric information concerns about the value of the firm. Investors may clink to sustainable firms when the economy faces systematic crises and the economy-wide trust levels fall. This uncertainty mitigation potential of sustainability could be present during the IPO procedure and could be related to the underpricing of the issue. Similar consequences should be present in the post IPO performance. Namely firms providing sustainability information have longer lives in the stock market and perform better during financial crises.

Our empirical evidence is based on a sample of 854 US IPOs from 2008-2017 for which we are able to retrieve firm-level data for three important aspects of sustainability, namely the environmental, social, and corporate. Our analysis develops around two key questions in mind: (i) How important is investing in sustainable practices to firm's financial performance?, (ii) Does investment in sustainable practices make firms more immune to financial crises? and (iii) Is sustainable investment a crucial aspect of firm's longevity?

We conjecture two possible impacts. First, sustainability increases transparency and trust for all stakeholders minimizing information asymmetry effects. Second, during periods of financial crisis this reduction in opaqueness tends to enhance valuation and performance for

disclosing firms. For our sample of US firms for the period 2008-2017 we find that ESG disclosure prior to the IPO significantly reduces underpricing. This result is consistent with the mitigation of asymmetric information. We examined whether this impact is enhanced during financial crisis period due to possible flight to quality. We find that there is a significant further reduction in underpricing for firms disclosing such information. We investigated the post IPO performance of ESG disclosure firms. We report week evidence that ESG positive firms outperform comparable firms during crisis. This suggests a similar flight to quality effect since investors during cold periods preferrer to be placed in safer investments. Finally, we tested whether ESG positive firms tent to remain listed longer. Our finding supports the proposition that ESG disclosure corresponds to prudent investment and governance strategies.This result remains robust using matching samples using three alternative methods.

The remainder of the chapter proceeds as follows. Section 3.2 introduces our analytical framework. Section 3 presents the data. Section 3.5 discusses the results. Section 3.6 summarizes the findings and concludes.

## 3.2 Theoretical Considerations and Hypothesis Development

Environmental, social and governance (ESG) objectives play a crucial role among companies that nowadays, are facing the imperative call for pursuing at the same time social, environmental and financial performance that leads to corporate sustainability enhancement (Kiron et al., 2013; Ng and & Rezaee, 2015). The pressure from stakeholders for better quality information and the demand for reporting standards such as transparency and accountability for large firms was critical to the success of sustainability, as it provided investors with more information. Firms that incorporate sustainability reports into their strategy will tend to reduce asymmetric information (Lu and Chueh, 2015). In addition will improve relationship with stakeholders, investors, employees, customers. Moreover, ESG disclosing, should help investors to identify long-term risk factors and investment opportunities. Eccles et al. (2014), found that companies with more sustainable business traits outperform their peers over the long term. (Goss and Roberts, 2011) report that there is a negative relationship between good environmental management practices and firm's loan spread. On the contrary they find a positive association between firms' environmental concerns and its loan spread. Lusardi et al. (2011), assert that there is positive relationship between toxic investing firms and loans spreads due to the significant risk incurred. Allegedly, these hazards costs will be such that will threaten the ability of a firm to meet its obligations to its creditors. Nair (2005), reports that the ESG strategy lead to lower cost of equity financing. Creditors consider that firms with ESG concerns may damage their reputation and financial position. Sadok El Ghoul and

Mishra (2011), add that the ESG strategy creates firm value. In this respect, ESG information framework helps investors and creditors to make quantitatively driven investments through a better understanding of economic risk. As a result, ESG increased in importance, as investment managers integrated sustainability into their investment strategy. Stock indices that have included ESG measurements are: Dow Jones, FTSE, MSCI, NASDAQ, OMX, NYSE and the S&P.

The impact of sustainability on firms as measured by ESG has been an important topic in the literature during the past years. Tamayo (2017) shows that during periods of financial crisis firms with high sustainability gain a competitive advantage in investor trust. Additionally, firms have higher profitability, growth, and sales compared with those with low ESG. Godfrey and Hansen (2009); Minor (2015); Cheng and Shue (2016) report that sustainability plays the role of insurance against firm's idiosyncratic risk. Further, Lu and Chueh (2015) investigate the relation between asymmetric information theory and corporate social responsibility. Their results indicate that there is a significant negative relation between sustainability and information asymmetry. They also find a reduction to the excess returns due to sustainability when there is high information asymmetry. Dan S. Dhaliwal and Yang (2011) report evidence that sustainability disclosure has beneficial impact for firms in the form of lower cost of equity. Despite the fact that these arguments highlight the importance of sustainability for the valuation of firms, the IPO literature has not examined yet the possible impact of sustainability (ESG) disclosure before the IPO on underpricing and post IPO performance. Following the literature, the common expectation is that firms who provide ESG information will be differentiate during the IPO procedure in relation to the firms which do not report such information. By voluntary publication of ESG information firms demonstrate commitment and the will to improve transparency. We make a testable prediction that firms who voluntary disclose information about ESG before the IPO, gain a competitive advantage by increasing their transparency, increasing investors trust (Tamayo, 2017) and raising capital in better terms during an IPO (Anderson and Frankel., 1980; Frankel and Wilson., 1995). We also argue, that this competitive advantage becomes much more significant during financial crisis both for the IPO and post IPO period.

In order to support our predictions, we develop testable hypotheses relating to the ESG disclosure information and its effect on firms IPO and post IPO performance.

### 3.2.1 The relation between sustainability and underpricing

Information disclosed about sustainability measured with the ESG index is inversely related to information asymmetry (Lu and Chueh, 2015). Such releases help investors to deal with the adverse selection problem arising along the IPO process.

*H1*: Firms that disclose sustainability information before the IPO, reduce asymmetric information concerning their value. In comparison with a matching sample of firms that do not disclose this type of information, these firms face less underpricing.

### 3.2.2 Sustainability and underpricing in cold periods

The IPO literature has linked underpricing to hot and cold stock market periods. During cold periods investors tend to liquidate their more risky portfolios and this will include their participation in IPOs.

*H2*: The effect in H1 becomes more pronounced for IPOs occurring during a period of financial crisis. Adverse selection problems are exacerbated during financial crisis periods and hence underpricing is increased. When a firm releases information which pertains to its quality it becomes more valuable during such periods and the impact should be depicted on firm valuation during the IPO.

### 3.2.3 The relation between sustainability and stock market performance: A flight to quality

During crisis periods actual returns are higher than expected for companies that disclose sustainability information compared with a matching sample. Disclosing firms gain competitive advantage in such periods because they are considered safer investments. This resembles a flight to quality effect. Investors will tend to sell more opaque firms and purchase firms which report information about their quality.

*H3*: During crisis periods, post IPO performance as measured by BHAR, for firms that have disclosed sustainability information prior to the IPO, is higher compared to a matching sample lacking this disclosures.

### 3.2.4 A direct test for the firm resilience generated by sustainability practices

The increased level of trust generated form sustainability reporting between customers, investors and firms has long term effects on profitability and growth of these firms. *H4*: Firms monitoring their financial, governance, environmental and social behavior by formulating appropriate strategies become more resilient. Their mortality rates are reduced, so that they are less likely to be post IPO delisted compared with a matching sample.

## 3.3 Data Description and Analysis

### 3.3.1 Sample Construction

We construct our sample using the population of US IPOs from Securities Data Company (SDC) New Issue Database for US. The sample period starts in January 2007 and ends in December 2017.We obtain information for aftermarket data from Compustat and Center for Research in Security Prices (SDC). Following the literature (Loughran, 2002), we exclude IPOs with offer price lees that 5$, leverage buyout (LBO), American depositary receipts (ADRs), real estate investment trusts (REITs), limited partnerships, rights, financial institutions, unit investment, trusts, unit offerings, standbys and best effort issues. The final sample consists of 854 firms. We further retrieve data for the main components of sustainability (ESG), namely the environmental (Environmental), social (Social) and corporate (Corporate) from RepRisk, Global Business Intelligence Database.There are 94 firms in our sample that disclose information according to monthly RepRisk Special Reports during the last year before the IPO.

### 3.3.2 Descriptive Statistics

Table 3.1 provides information for the distribution of our US IPO sample during the period 2008 to 2017 by issue year .

Table 3.1: IPO Distribution By Issue Year

| Year | All IPOs (N=854) | | IPOs with non-ESG information (N = 760) | | IPOs with ESG information (N = 94) | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| 2008 | 12 | 1,4 | 11 | 1,5 | 1 | 1,0 |
| 2009 | 34 | 3,9 | 31 | 4,1 | 3 | 3,1 |
| 2010 | 75 | 8,7 | 68 | 8,9 | 7 | 7,5 |
| 2011 | 79 | 9,2 | 67 | 8,7 | 12 | 12,8 |
| 2012 | 88 | 10,3 | 78 | 10,3 | 10 | 10,7 |
| 2013 | 139 | 16,3 | 120 | 15,7 | 19 | 20,3 |
| 2014 | 167 | 19,6 | 152 | 20,0 | 15 | 15,9 |
| 2015 | 105 | 12,3 | 90 | 11,7 | 15 | 15,9 |
| 2016 | 66 | 7,7 | 59 | 7,8 | 7 | 7,4 |
| 2017 | 91 | 0,6 | 86 | 11,3 | 5 | 5,4 |

Notes: This table reports pairwise correlations of variables used in the study. The sample includes 854 U.S. IPOs announced between 2008 and 2018. IPO deals are retrieved from the Securities Data Company (SDC) Database with aftermarket and accounting data obtained from CRSP and Compustat databases respectively. ESG_disclose data comes from the RepRisk database. All variables are defined in Appendix A.

The majority of IPOs is concentrated from 2011 to 2015, which is contemporaneus with the recovery of the U.S. economy after the early 2009's recession. The density of IPO appears to be reduced over the time of crisis. Overall, we see that most of the firms do not disclose ESG information before the IPO; only 12% of companies in our sample divulge information for ESG prior the IPO.We farther verify this finding from firms prospectuses. Moreover, our sample is the first in the literature that reports information regarding ESG prior to the IPO.

Further, as Table A.2 in the Appendix shows, there is no high correlation between the variables.

## 3.4 Econometric Setup

### 3.4.1 IPO Underpricing and post IPO Performance

We study the relation between sustainability and underpricing by testing indirectly the effect of ESG disclosing on information asymmetry (H1).Moreover, we test the effect of ESG disclosure during cold periods (H2). Additionally we test for the association between sustainability and stock market performance (H3) which is a test of the fly to quality assumption. Therefore we estimate the following models:

$$\ln(Underpricing_i + 1) = a_0 + a_1 ESGdisclose_i + Controls_i + e_i \quad (3.1)$$

$$BHAR_i = a_0 + a_1 ESGdisclose_i + Controls_i + e_i \quad (3.2)$$

Where the dependent variables; underpricing equals to the difference between the closing price and offer price divided by offer price; BHAR is firms buy and hold abnormal returns. We use monthly RepRisk Special Reports to construct ESG_Disclose which is our variable of interest. If firm has report information for ESG during the year before the IPO then the dummy variable takes the value 1 and 0 otherwise. If $a_1 < 0$ then based on the arguments in the previous section, the reduction of asymmetric information drives firms that report ESG to be less underpriced. The Controls variables follow the traditional IPO underpricing literature. Younger firms tend to be more risky to their investments . We control for the number of years that the firm is operating which according to the literature (Ritter, 1984, 1991; Carter et al., 1998) has been employed as a factor that generates risk; For visibility of the firm to investors that could arise from a large value of Proceeds and result lower underpricing. IPO Proceeds is the amount in millions of US dollars; Earnings takes the value of 1 if the year prior to the IPO the firm discloses earnings and 0 otherwise. The literature has not concluded to a clear sign of this variable to IPO underpricing as profitability in one year may not be a credible indicator to long-term post-IPO performance especially in light of exogenous shocks; Leverage is the ratio of total liabilities over total assets before the IPO. Studies have shown that firms relying on debt to be less inclined to accept a high underpricing (Jensen, 1986); UnderwriterRank is collected by Loughran and Ritter (2004) and takes the value of 1 if the underwriter is prestigious and 0 otherwise. Carter and Manaster (1990) show that IPOs with prestigious underwriters are more likely to result to underpricing. This finding's intuition is that established underwriters are less likely to be involved with IPOs of questionable quality. Overhang is calculated as the ratio of shares retained by pre-IPO shareholders to the equity given up in IPO. A large value of Overhang could imply that underpricing bears no costs to the pre-IPO shareholders (Bradley and Jordan, 2002). We also include Revisions which is the change of the IPO offer price from the midpoint of the initial filing price range. Any change is likely to indicate new information revealed to the underwriter by the time of listing (Hanley, 1993; Goldreich, 2002)

We further include year dummies and various industry-related dummies. Specifically, Internet takes the value of 1 if the firm is classified as an internet firm and 0 otherwise. Technology takes the value of 1 if the firm belongs to SIC codes that technology intensive industries. Nasdaq takes the value of 1 if the firm's IPO was in NASDAQ and 0 otherwise.

We further include year and various industry dummies and distinguish firms by their first digit SIC classification. Our baseline estimation is Ordinary Least Squares (OLS).

Due to the latter point, we also perform propensity score matching in the spirit of Rosenbaum and Rubin (1983) following the algorithms set by Becker and Ichino (2002). The propensity score method in essence matches the firms that report information for their ESG activity the previous year to IPO with a firm, or firms, that do not (i.e. control firms) based on the rest of the control variables in the specification. To provide robustness that our results are not driven by different matching methods, we perform the three most common ones (Zhao 2004); The nearest neighbor, kernel and stratification.

### 3.4.2 Longevity

There is an extensive IPO literature that examines by using Survival analysis the influence of various factors on firms longevity and probability of failure (Hall, 1987; Ericson and Pakes, 1995; Prez et al., 2004; Cefis, 2005; Geroski, 1995; Audretsch, 1995; Hielke Buddelmeyer and Wooden, 2010; Tsvetkova and Macy, 2014; Ugur et al., 2016; rim Ha et al., 2016). To support our hypothesis that firm resilience is generated by sustainability practices (H4), which is a direct test that firm's mortality rates are reduced when firms report ESG information, we examine the hazard rate of exiting the stock market following the Cox proportional hazard model Cox (1972). We choose this model because it's advantage over the others hazards models of the non pre-specification form of it's baseline function.

$$h_{Exit}(t, ESGdisclose_i, Controls) = h_0(t)\exp(b_0 + b_1 ESGdisclose_i + b_2 Controls_i) \quad (3.3)$$

We do collect data on the survivability of our firms in the sample. In particular we collect in years, the time that each firm remains public. hExit is the probability that the firm i exits the stock market (gets delisted) at period t (counted in years, from the firm's IPO month), given that it has not been previously delisted. The rest of the variables are defined at section 3.4.1.We expect a negative sign ( $b_1 < 0$ ) in order to support hypothesis (H4); that firms with ESG reports prior to IPO have a lower hazard of being delisted. We include fixed effects for years and sectors at two digit industry code level.We present our results in section 3.5 below.

## 3.5 Empirical Results

### 3.5.1 The Effect of ESG on Underpricing

Table 3.2 provide the results from the estimation of equation 4.1 via OLS. The signs of control variables are in line with the prior literature even though they are not always significant.Column 1 reports that the coefficient of ESG_disclose is negative and statistical significant at the 1% .For instance firm that disclose information about their ESG activities face 11,5% less underpricing compare with those who do not.This result verifies the hypothesis (H1) that Firms that disclose sustainability information before the IPO, reduce asymmetric information concerning their value and face less underpricing. In column 2 we test this result for IPOs that take place over the cold periods.We find that the the effect of ESG_disclose becomes even more intense. The interaction term ESG_disclose_x_Crisis shows that in cold periods ESG reports before the IPO reduce the underpricing additional by 12,2%.This coefficient is significant at the 1% level.This outcome supports the hypothesis (H2) that the effect of ESG in H1 becomes more pronounced for IPOs occurring during the period of financial crisis.

Table 3.2: The Role of ESG Report to Underpricing

| Dependent Variable: Underpricing | | |
|---|---|---|
| VARIABLES | (1) | (2) |
| ESG_disclose | -0.115*** | -0.111*** |
| | (0.038) | (0.039) |
| Crisis | 0.125** | 0.135** |
| | (0.056) | (0.055) |
| ESG_disclose_x_Crisis | | -0.122** |
| | | (0.056) |
| Overhang | 0.001 | 0.001 |
| | (0.002) | (0.002) |
| Revisions | 0.006*** | 0.006*** |
| | (0.001) | (0.001) |
| Leverage | -0.003** | -0.003** |
| | (0.001) | (0.001) |
| Nasdaq | 0.001 | 0.001 |
| | (0.031) | (0.031) |
| Earnings | 0.002 | 0.002 |
| | (0.027) | (0.027) |
| Internet | -0.032 | -0.032 |
| | (0.054) | (0.054) |
| UnderwriterRank | 0.015 | 0.015 |
| | (0.032) | (0.032) |
| Proceeds | -0.012 | -0.011 |
| | (0.066) | (0.066) |
| FirmAge | 0.023** | 0.024** |
| | (0.012) | (0.012) |
| Observations | 854 | 854 |
| R-squared | 0.096 | 0.096 |
| Year FE | YES | YES |
| Industry FE | YES | YES |

Notes: Columns 1 and 2 include ESG as focal independent variable and estimated via OLS. Column 2 focus on ESG disclosing information effect during cold periods, proxy by *ESG_disclose_x_Crisis*. In all columns, standard errors reported in parentheses are adjusted for heteroskedasticity; *** p<0.01, ** p<0.05, * p<0.1

### The Effect of ESG on Underpricing.Testing in matching samples

For robustness in order to alleviate endogeneity concerns, Table 3.3 reports propensity score matching techniques. Columns 1-3 display the results where we consider ESG_disclose before the IPO as the treatment dummy; each column indicates a different matching method;

i.e. means of the nearest neighbor, kernel and stratification respectively Yu (2006). The coefficient of ESG_disclose ranges from -0.144 to -0.073 and is always significant. These results support the outcome from the OLS analysis in the previous Table and indicate that the role of ESG_disclose is not likely to be attributed to confounding factors. In sum Table 3.3 provide evidence for additional support to hypothesis (H1) and (H2) that ESG reports before the IPO reduce asymmetric information.

Table 3.3: Role of ESG Reports in IPO underpricing. Propensity Score Matching

Dependent Variable: Underpricing

| | Treatment Variable: *ESG_disclose* | | |
|---|---|---|---|
| VARIABLES | (1) | (2) | (3) |
| Nearest neighbor | -0.144** | | |
| | (0.057) | | |
| Kernel | | -0.085** | |
| | | (0.043) | |
| Stratification | | | -0.073* |
| | | | (0.044) |
| Observations | 854 | 854 | 854 |

Propensity score techniques. In Columns 1-3 we select the ESG_disclose dummy based on the control variables of Table 2; that is, FirmAge, Proceeds, Internet, Earnings, Nasdaq, UnderwriterRank, Revisions, Overhang and Leverage.Column 1 employ the nearest neighbor method, Column 2 the kernel and Column 3 the stratification method (Zhao 2004). An asterisk indicates significance at the 10% level; two indicate significance at the 5% level; three indicate significance at the 1% level.

### 3.5.2 The Effect of ESG disclosing information on post IPO Performance

Table 3.4 provide the results between the disclosing of ESG information and the post-IPO market performance of firm corresponding in Hypothesis that investors flight to quality (H3). It report's the association between ESG_disclose buy and hold abnormal returns and cumulative abnormal returns. In order to construct monthly portfolio buy-and-hold abnormal returns (BHAR) and cumulative abnormal returns (CAR) we retrieve stock return data from Center for Research in Security Prices (CRSP) and monthly factors return realization by Kenneth French's data library.We follow Loughran et al. (1995) and take time periods of 255

trading days to construct the BHAR and CAR for the first year IPO. Our results indicate a positive association between ESG_disclose information before the IPO and firms buy and hold and cumulative abnormal returns.

All Columns are estimated via OLS and report the abnormal returns for the first 255 days after the IPO.Columns 1 and 2 consider BHAR and CAR following Fama-French three-factor model while columns 3 and 4 follow Carhart four-factor model including monthly momentum. The signs of control variables are in line with the existing literature even though they are not always significant.

In column 1 ESG_disclose has a negative sign; Firms that disclose ESG information on the average have 3.1% less post IPO performance;On the contrary, the interaction term ESG_disclose_x_Crisis shows that in cold periods firms that report ESG information before the IPO compare with those who do not face increased post IPO market performance proxy by BHAR and CAR by additional 5,8%. An asterisk indicates significance at the 10% level; two indicate significance at the 5% level; three indicate significance at the 1% level. This results suggest that firms with public available ESG information gain competitive advantage in cold periods because they are considered safer investments (H3).

Table 3.4: The Role of ESG Report to Post IPO Performance

| | Buy and Hold Abnormal Returns and Cumulative Abnormal Returns for the first year | | | |
|---|---|---|---|---|
| | *Fama-French three-factor model* | | *Carhart four-factor model* | |
| VARIABLES | BHAR1 | CAR1 | BHAR1 | CAR1 |
| | (1) | (2) | (3) | (4) |
| ESG_disclose | -0.031* | -0.027* | -0.033** | -0.028* |
| | (0.016) | (0.016) | (0.016) | (0.016) |
| ESG_disclose_x_Crisis | 0.058** | 0.058* | 0.059** | 0.058* |
| | (0.029) | (0.031) | (0.030) | (0.031) |
| Crisis | -0.039 | -0.033 | -0.029 | -0.023 |
| | (0.036) | (0.035) | (0.038) | (0.036) |
| Overhang | 0.001* | 0.001** | 0.001* | 0.001** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Revisions | -0.001 | -0.001 | -0.001 | -0.001 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Leverage | -0.002 | -0.002 | -0.002 | -0.002 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Nasdaq | 0.014 | 0.015 | 0.012 | 0.013 |
| | (0.013) | (0.012) | (0.013) | (0.012) |
| Earnings | -0.002 | -0.001 | -0.003 | -0.002 |
| | (0.012) | (0.011) | (0.012) | (0.012) |
| Internet | -0.026 | -0.027 | -0.030 | -0.031 |
| | (0.024) | (0.024) | (0.024) | (0.024) |
| UnderwriterRank | 0.023 | 0.022 | 0.022 | 0.022 |
| | (0.019) | (0.018) | (0.019) | (0.018) |
| Proceeds | 0.027 | 0.021 | 0.030 | 0.024 |
| | (0.034) | (0.032) | (0.034) | (0.032) |
| FirmAge | 0.011** | 0.010** | 0.011** | 0.010** |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| Observations | 790 | 790 | 790 | 790 |
| R-squared | 0.065 | 0.064 | 0.064 | 0.063 |
| Year FE | YES | YES | YES | YES |
| Industry FE | YES | YES | YES | YES |

Notes: Columns 1 and 2 include Buy and Hold Abnormal Returns for the first 255 trading days following the IPO constructed by Fama-French three-factor and Carhart four-factor models respectively as focal independent variable.We estimated our model via OLS and focus on ESG disclosing information during cold periods proxy by ESG_disclose_x_Crisis on buy and hold and cumulative abnormal returns. Standard errors reported in parentheses are adjusted for heteroskedasticity. An asterisk indicates significance at the 10% level; two indicate significance at the 5% level; three indicate significance at the 1% level.

### 3.5.3 The Effect of ESG disclosing information on firms longevity

Our econometric analysis is presented in Table 3.5. Column 1 considers the total sample. Firms with ESG_disclose prior to IPO have a 1-exp(-0.127)=11.9% less hazard to get delisted from the US stock market than firms w/o ESG. This difference is statistically significant at 1% level. Additional, column 2 reports similar OLS regression but the survival time of IPO firms is right censored. This result is in line with hypothesis (H1),(H2)and(H3) and provides prima facie support that firms monitoring their financial, governance, environmental and social behavior by formulating appropriate strategies gain competitive advantage and become more resilient (H4).

Table 3.5: The Role of ESG Report to Post IPO Performance

| VARIABLES | (1) | (2) |
|---|---|---|
| ESG_disclose | -0.127*** | -0.125*** |
| | (0.039) | (0.038) |
| Proceeds | -0.426*** | -0.447*** |
| | (0.070) | (0.068) |
| Overhang | -0.004*** | -0.004*** |
| | (0.001) | (0.001) |
| Revisions | -0.004*** | -0.004*** |
| | (0.001) | (0.001) |
| Leverage | -0.001 | 0.001 |
| | (0.000) | (0.001) |
| Nasdaq | -0.112** | -0.108** |
| | (0.048) | (0.049) |
| Earnings | -0.140*** | -0.137*** |
| | (0.017) | (0.018) |
| Internet | 0.129 | 0.129 |
| | (0.146) | (0.147) |
| UnderwriterRank | 0.169*** | 0.176*** |
| | (0.023) | (0.024) |
| FirmAge | 0.039*** | 0.040*** |
| | (0.006) | (0.007) |
| Observations | 847 | 847 |

Notes:The table illustrates the estimation of Cox proportional hazards model of probability of delisting. Column 1 considers all firms. The overall sample is reduced by 7 firms as these firms exited at the year of IPO (t=0). In column 2 the survival time of IPO firms is right censored. IPO year fixed effects are included in all specifications. In all columns, standard errors reported in parentheses are adjusted for heteroskedasticity. An asterisk indicates significance at the 10% level; two indicate significance at the 5% level; three indicate significance at the 1% level.

## 3.6 Conclusion

In this chapter we examine whether sustainability reporting has become a significant factor in firm valuation and performance. We conjecture two possible impacts. First, sustainability increases transparency and trust for all stakeholders minimizing information asymmetry effects. Second, during periods of financial crisis this reduction in opaqueness tends to enhance valuation and performance for disclosing firms. For our sample of US firms for the period 2008-2017 we find that ESG disclosure prior to the IPO significantly reduces underpricing. This result is consistent with the mitigation of asymmetric information. We examined whether this impact is enhanced during financial crisis period due to possible flight to quality. We find that there is a significant further reduction in underpricing for firms disclosing such information.

We investigated the post IPO performance of ESG disclosure firms. We report week evidence that ESG positive firms outperform comparable firms during crisis. This suggests a similar flight to quality effect since investors during cold periods preferrer to be placed in safer investments.

Finally, we tested whether ESG positive firms tent to remain listed longer. Our finding supports the proposition that ESG disclosure corresponds to prudent investment and governance strategies.This result remains robust using matching samples using three alternative methods.

# Chapter 4

# How Important are Capital Controls in Shaping R&D Activity?

## 4.1 Introduction

Research and Development (R&D) is an important input of innovation, crucial factor for a country's competitive position in international markets and a powerful driver for long-run economic growth. Typically, endogenous growth models have shown that economic growth is driven by innovation activity carried out locally as well as by the capability of a region to learn from external technological achievements (Romer, 1986; Grossman and Helpman, 1991a). The ability of knowledge to spill across firms and countries indicates that socially optimal rates of R&D are likely much higher than privately optimal levels (Hall et al., 2010), which in turn makes R&D a key factor in shaping income (in)equality across regions and countries (Saxenian, 1994; Swann et al., 1998; Verspagen, 1999; Coe et al., 2009).

Innovation activity, however, involves high probability of failure as the whole process is long, idiosyncratic and unpredictable, with many future contingencies that are hard to foresee (Holmstrom, 1989). From the perspective of investment theory, R&D has a number of characteristics that make it different from ordinary investment. Most importantly, more than half of a firm's R&D spending is the wages and salaries of highly educated scientists and engineers (Hall et al., 1986). Their efforts create an intangible asset, the firm's knowledge base, from which profits in future years will be generated. To the extent that this knowledge is 'tacit' rather than codified, it is embedded in the human capital of the firm's employees. This resource base, however, disappears when researchers leave or are fired and because projects often take a long time between conception and commercialization, firms tend to smooth their R&D spending over time, in order to avoid having to lay off knowledge workers. This

implies that R&D spending at the firm level usually behaves as though it has high adjustment costs (Hall et al., 1986; Lach and Schankerman, 1988). Furthermore, as most of the R&D expenditure is wages and salaries of highly-skilled researchers, liquidity constraints, or excess sensitivity to cash flow shocks make innovation activity very susceptible to financing frictions more than other investments (Brown et al., 2009, 2012). Financial barriers that segment international markets increase financial constraints for domestic firms that do not have direct access to international capital markets (Rajan and Zingales, 1998; Forbes, 2007), drive up the cost of capital (Stulz, 1999; Chari and Henry, 2004b) and increase uncertainty which can lower firm investment and particulary R&D activity. This can result to R&D investment below the privately optimal level leading to lower levels of innovations and economic growth.

The prevailing view, for many years, among economists has been that free capital mobility brings many potential welfare gains such as reduction of the cost of capital, increase of investment, economic growth (Chari and Henry, 2004a,b, 2008) and international diversification gains for foreign investors (Brennan and Cao, 1997; French and Poterba, 1991; Adler and Dumas, 1983), whereas financial restrictions are nearly bad.[1] However, this decades-long view has begun to shift, especially after the currency crisis of the middle of 2000 and the 2008 global financial crisis, and capital controls made an intellectual comeback becoming part of the policy discussion.

After long urging countries to free the movement of capital, the International Monetary Fund (IMF) surprised economic policy makers by endorsing and even recommending the imposition of taxes or controls, in some cases, when countries have few other options (Blanchard and Ostry, 2012).[2] Other prominent calls have gone further towards a greater acceptance of the use of capital controls as a regular tool of policy (Jeanne et al., 2012; Rey, 2013). Some of these policy prescriptions are consistent with a new branch of theoretical research in which capital controls contribute to financial stability and macroeconomic management (Jeanne

[1]These views are best reflected in Dornbusch (1998) "Capital Controls: An Idea Whose Time is Gone." A recent stream of research also raises concerns about the effectiveness of capital controls and their potential costs. Eichengreen and Rose (2014) present a thorough discussion on capital controls in modern economies and suggest that such measures should be used as a last resort, after first-best policies have been exhausted. Capital controls tend to favor distortions in domestic policy (Alesina et al., 1993), limit the effectiveness of monetary policy (Mitchener and Wandschneider, 2015) and are prone to corruption (Schmidt, 2001). Other studies argue that capital controls are irrelevant when dealing with real economic crises and particularly with output and exchange rate fluctuations (Klein, 2012; Fernandez et al., 2013, 2015b).

[2]The experience of a handful of advanced economies, which were entirely open to global capital flows and were hit hard by the global financial crisis, contributed to the reconsideration and implementation of capital controls by the IMF and policy makers. Iceland and Spain both experienced deep recessions when the foreign investment that had driven booms in their economies evaporated. Similar lessons were drawn during the Eurozone crisis. Greece and Cyprus, both facing sudden outflows over fears their banks would fail, put strict restrictions on bank transfers to stop money from leaving. Even Swiss policymakers spoke of the possible use of controls on capital inflows as the franc strengthened against the euro and the dollar (Financial Times, May 2012).

and Korinek, 2010; Bianchi, 2011; Benigno et al., 2013, 2014) and therefore limits to capital mobility are desirable, especially over the short-term (Bhagwati, 1998; Rodrik, 2000).

While the case for capital controls rests on promoting prudential controls designed to mitigate the volatility of foreign capital inflows, there is also an implicit aspect of controls that is protectionist in nature aimed at maintaining persistent currency undervaluation. The extent to which policymakers should limit foreign capital mobility, remains a controversial issue as the empirical evidence is rather mixed.[3] and is extremely thin on the potential impact of capital controls on innovation activity.

The present chapter examines the effects of capital controls on countries' innovation activity. Our model derives from an innovation production, in the endogenous growth paradigm (Ha and Howitt, 2007; Ang and Madsen, 2011), where local factors and external knowledge (Jaffe, 1986; Audretsch and Feldman, 1996) shape local innovative activity. To unfold the effects of capital controls on innovation, the chapter employs a new data set that differentiates between controls on inflows and on outflows as well as among different asset categories allowing a more detailed analysis than with most other capital control databases and indices. Furthermore, we explore how the effects may vary across different institutional settings and technology performances. The chapter aims to contribute to evolving debate on the effects of international capital controls -through the channel of R&D financing- on economic growth.

Our work relates to a broader literature on growth-finance nexus (King and Levine, 1993; Jayaratne and Strahan, 1996; Levine and Zervos, 1998; Rajan and Zingales, 1998; Beck et al., 2000; Beck and Levine, 2002; Black and Strahan, 2002). The focus on R&D, a specific channel through which finance affects economic growth, also brings us to a rapidly growing strand of literature on innovation performance and (type of) finance. Recent contributions have examined the link between financial development and innovation, supporting that the development of equity markets encourages innovation activity, while the development of credit markets impedes it (Hsu et al., 2014). Further, access to external financing is found to be associated with greater firm innovation (Ayyagari et al., 2011), pointing at the major role of external equity in financing R&D (Brown et al., 2009, 2012).

We also relate to the literature on financial openness and economic growth (Kose et al., 2009; Obstfled, 2009; Quinn and Toyoda, 2008; Quinn et al., 2011). The empirical evidence this literature, however, is rather weak or mixed, particularly for developing countries. For instance, the study of Prasad et al. (2003) finds no significant relationship between financial openness and growth across countries. Similarly, Satyanath and Berger (2007) fail to establish

[3] See Forbes (2005) and Satyanath and Berger (2007) for extensive reviews of the theoretical and empirical literature.

statistically significant linkage between capital controls and capital inflows and economic growth prior to the global financial crisis in a panel of 50 (mostly) emerging economies. A thin micro-level based evidence on the effects of capital controls on firm's finance and real activity shows that by lifting capital controls countries experience the positive benefits predicted by economic theory (Harrison et al., 2004).[4]

Thus far, relevant research has studied the effects of capital controls on macro aggregates such as exchange rates, inflation, public debt and economic growth (Schmidt, 2001; Klein, 2012; Mitchener and Wandschneider, 2015; Fernandez et al., 2013, 2015b), while innovation has received less attention. Further, the financing of R&D is an important channel that links the financial and real economy. Consequently, financial barriers that affect R&D also affect growth. Our work adds to the literature by specifically examining the effects of financial restrictions on R&D. Motivated by the aforementioned evidence, this chapter contributes to existed empirical literature by studying the effect of international financial barriers, and specifically which capital asset restrictions and under what conditions and arrangements, on countries' innovation activity. Our study may abstract from heterogeneity at the firm level and that could be a potential caveat compared with event studies (Johnson and Mitton, 2003; Forbes, 2007; Alfaro et al., 2017), but employs appropriate econometric estimation techniques and various splits of the data this chapter to perform a comprehensive analysis.

Our empirical analysis is based a sample of 54 countries, developed, emerging and developing, with various degrees of capital restrictions, over the period 1995-2013 with two key questions in mind: (i) How important are capital controls in shaping R&D activity? and (ii) What asset restriction, in particular, is the least conductive to R&D activity?

The evidence we provide is straightforward: Our findings clearly demonstrate that in general capital controls impede R&D activity; however, their effect may well vary depending on the level of financial development and technology export profile of a country. High level of development in the financial sector smooths out some of the adverse effects of capital restrictions on R&D, while countries with high-tech export orientation could be more sensitive to capital restrictions. Controls on capital outflows have stronger impact on domestic R&D activity than controls on the inflows. Finally, restrictions on different capital

[4]The study of Forbes (2007) examines the impact of capital controls as opposed to the benefits of liberalization using Chilean data from the 1990s and shows that during the Chilean encage small traded firms experience significant financial constraints. Alfaro et al. (2017) investigate the effects of capital controls on firm-level stock returns and real investment bringing evidence from Brazil, as the country has implemented a series of extensive controls on capital flows between 2008 and 2012. Their findings indicate that capital controls increased the cost of capital, reduced the availability of external finance and lowered firm-level investment. A different angle of view is offered from Johnson and Mitton (2003) who based on Malaysian evidence argued that despite the potential costs, imposing restrictions on capital flows may also limit cronyism due to the similar extent that capital resources would be limited to politically connected and non-connected firms alike.

assets also have different implications, with controls on money market and commercial credit to be by far the most detrimental for innovation.

We can derive some policy implications based on or findings. Our evidence indicates that financing constraints do matter for the R&D investment. Contrary to much of the existing literature that provide weak or no evidence at all on macroeconomic aggregates, we find a clear negative effect. Our study, further, highlights an important role of the level of financial development, which next to its upmost importance to a country's economic activity also ameliorates the negative consequences of capital controls on innovation activity and eventually on economic growth. Strengthening thus financial institutions, especially in countries that were hit hard from recent financial crisis, would therefore provide a means for better insulation against financial shocks. In implementing capital restrictions, policy makers should be more cautious for countries with high-tech export orientation, as technology firms could be more vulnerable to finance availability restrictions in order to advance their technology and remain competitive.

The remainder of the chapter proceeds as follows. Section 4.2 introduces our analytical framework. Section 3 presents the data. Section 4.4 discusses the results. Section 4.5 summarizes the findings and concludes.

## 4.2 Analytical Framework

This section lays out the theoretical background and presents the econometric framework of our empirical analysis.

### 4.2.1 Theoretical Background and Empirical Specification

The recent advancement of endogenous growth theory has been the emergence of R&D-based models of economic growth. At the very heart of these models is the technological knowledge (or 'ideas') production function that describes the evolution of technological knowledge creation.

A simplified version of endogenous growth models assumes that output, $Y$, in country $i$ at time $t$ is produced by using labor, $L$, and technology, $A$. There are two sectors, the goods sector that produces output and the R&D sector that produces new knowledge. Labor is fixed, but it can be freely allocated to either of the two sectors, to produce output ($L_Y$) or to produce new knowledge ($L_A$).

New knowledge, 'ideas', are generated in the R&D sector. Let $A$ denote the stock of knowledge available in the economy. The knowledge stock can simply be though of as

the accumulation of all the ideas that have been invented or developed by people. Then $\dot{A}$ represents the flow of new knowledge or the number of new ideas generated in the economy at a point in time. New ideas are produced by researchers, $L_A$, according to the following production function:

$$\dot{A} = \tilde{\delta} L_A \tag{4.1}$$

where $\tilde{\delta}$ denotes (average) research productivity and is modeled as a function of the existing stock of knowledge/ideas ($A$) and the number of researcher ($L_A$) according to:

$$\tilde{\delta} = \delta A^{\phi} L_A^{\lambda - 1} \tag{4.2}$$

where $\delta$>0, $\phi$ returns to scale in knowledge, and $\lambda$ duplication parameter (0 if all innovations are duplications and 1 if there is no duplicating innovations) - all are constant parameters; $A^{\phi}$ captures the dependence of current research productivity on the stock of ideas that have already been discovered: ideas in the past may facilitate the discovery or creation of ideas in the present ($\phi$>0) indicating a positive "spillover of knowledge" to future researchers or the most obvious ideas might have been discovered first and new ideas become increasingly harder to find over time ($\phi$<0); and $L_A^{\lambda-1}$ captures the dependence of research productivity on the number of people seeking out new ideas at a point in time - it is quite possible that the larger the number of people searching for ideas is, the more likely it is that duplication or overlap in research would occur in which case research productivity is decreasing in $L_A$.

Taken together, equations (4.1) and (4.2) suggest the following knowledge (or ideas) production function:

$$\dot{A} = \delta A^{\phi} L_A^{\lambda} \tag{4.3}$$

Particular forms of knowledge production function, depending on the restrictions imposed on $\phi$ and $\lambda$ and existence of product proliferation, have emerged in the endogenous growth paradigm.[5]

[5]The so-called 'first-generation' endogenous growth models (Romer's 1990 version and subsequent works of Grossman and Helpman (1991a), Segerstrom et al. (1990) and Aghion and Howitt (1992) among other), assume new ideas are linear to the existing stock of knowledge, holding research labor constant ($\phi$=1 and $\lambda$=1). This 'scale effect' prediction (i.e., growth rate of technology depends on the *level* of resources devoted to R&D), however, has been proven to be troublesome as it sharply contrasted with empirical evidence (Jones, 1995b). To eliminate such prediction a 'second-generation' endogenous growth models, and particularly the semi-endogenous (Jones, 1995a; Kortum, 1997; Segersrom, 1998), abandon the scale effects in the ideas production in favor of diminishing returns to the existing stock of knowledge ($\phi$<1). Another class of models on scale and growth, the Schumpeterian (or fully-) endogenous growth models (Aghion and Howitt, 1998;

An encompassing expression, which nests different classes of endogenous growth models, was suggested by Ha and Howitt (2007) and Ang and Madsen (2011) yields the following expression:

$$\frac{\dot{A}}{A} = \delta(\frac{X}{Q})^{\lambda} A^{\phi-1},\ Q \propto L^{\beta} \tag{4.4}$$

where, $X$ is innovation activity, $Q$ product variety, and $\beta$ parameter of product proliferation.[6]

As the growth rate of the economy, in the long-run, is driven by the growth rate of new technological advancements, the role of R&D activity is of upmost importance in generating new technologies and consequently economic growth. We, therefore, focus on innovation input ($X/Q$) and how is shaped by capital controls and estimate the following equation:

$$\begin{aligned} X/Q_{it} = \beta_i + \beta_1 X/Q_{it-1} + \beta_2 FD_{it} + \beta_3 CA_{it} + \beta_4 Institutions_{it} + \\ \beta_5 Imports_{it} + \beta_6 FDI_{it} + \beta_7 InventorInflows_{it} + \beta_8 S_{it} + \beta_9 Z_{it} + \varepsilon_{it} \end{aligned} \tag{4.5}$$

where $X/Q$ is innovation activity in country $i$ at time $t$, $CA$ is strictness of capital controls, $FD$ is an index of financial development, $Institutions$ is a set of indices that capture the quality of economic institutions and particularly of governance, $Imports$ is imports share to GDP, $FDI$ is foreign direct investment inflows to GDP, $InventorInflows$ is the number of inventor flows to country $i$, $S$ is a set of variables of economy's social and sectoral structure, $Z$ is a set of interaction terms, and $\varepsilon$ is an i.i.d. error term.

The dependent variable ($X/Q$) could be a range of innovation-related indices depending on the endogenous growth paradigm. It could be the number of research workers (scientists) in Romer's model, or R&D spending (to GDP) in the semi-endogenous growth theory, or productivity-adjusted R&D input in the Schumpeterian (fully-endogenous) growth theory.[7]

Dinopoulos and Thompson, 1998; Young, 1998; Peretto and Smulders, 2002), maintain the assumption of constant returns to the stock of existed knowledge ($\phi$=1), but further assume that the effectiveness of R&D is diluted due to the product proliferation as an economy grows and for sustained growth of knowledge, R&D has to increase over time to counteract the increasing range and complexity of products, which decreases the productivity effects of R&D activity.

[6]The range of the parameters $\phi$ and $\beta$ can distinguish the endogenous growth theory at work and predict the growth rate of knowledge and economy. In the *first-generation* endogenous growth models ($\phi$=1 and $\beta$=0), the growth rate of knowledge (economy) is $g_A = \frac{\dot{A}}{A} = \lambda X^{\sigma}$. In the *second-generation* endogenous growth models, and particularly in the semi-endogenous theory ($\phi$<1 and $\beta$=0), the growth rate of knowledge (economy) is equal to $g_A = \lambda X^{\sigma} A^{\phi-1}$, $\phi < 1$, while in the Schumpeterian (or fully-) endogenous growth models ($\phi$=1 and $\beta$=1), the growth rate of knowledge (economy) equal to $g_A = \delta(X/Q)^{\lambda}$.

[7]Product variety ($Q$) is usually measured by the size of population or employment (Aghion and Howitt, 1998; Ha and Howitt, 2007) or by GDP (Krugman, 1989), or by the stock of trademarks (Madsen, 2008). As it

Financial institutions are important for innovation and, therefore, we include the level of a country's financial development ($FD$). The level of financial development and its effect on economic growth has been largely investigated in the finance-growth literature (Schumpeter, 1911).[8] A newly grown literature has switched its focus rather on the finance-innovation nexus (Brown et al., 2009, 2012; Ayyagari et al., 2011; Hsu et al., 2014). This literature has provided strong evidence that availability of finance matters for R&D, documenting the importance of external equity in financing R&D.

Restrictions on various financial assets, reflected on the strictness of capital controls ($CA$), could also shape a country's innovation performance. Capital controls are rules, taxes or fees associated with financial transactions that discriminate between domestic residents and those outside the country (OECD, 2009).[9] Theory suggests that the imposition of capital controls segment international financial markets, drive up the cost of capital and curb investment (Stulz, 1999; Chari and Henry, 2004b). Credit constraints at the firm level are also more likely to bind for firms that are more dependent on external finance (Rajan and Zingales, 1998; Forbes, 2007). As we have information on capital restrictions for ten categories of assets, we further explore the type of asset restrictions that have the highest association with R&D investment.

Governance (and its quality) is among the key institutions for long-term economic growth (Mauro, 1995; Hall and Jones, 1999; Robinson et al., 2005). They can affect growth in vicarious channels.[10] Poor economic institutions -corruption, red tape, weak protection of

has been argued, the latter, is a good measure of product variety and outperforms the rest, when the number of products produced under the same trademark is relatively constant over time (Gao and Hitt, 2012).)

[8]Financial markets play critical role in mobilizing savings, evaluating projects, managing risk, monitoring managers, and facilitating transactions (Bencivenga and Smith, 1991; Jappelli and Pagano, 2002). The development of financial markets also matters in increasing the productivity of investment (Greenwood and Jovanovic, 1990; King and Levine, 1993). In the absence of a sound and efficient financial system, foreign capital inflows may be misallocated, resulting in growth-crippling financial crisis. Evidence has shown that the size and depth of an economy's financial system positively affects its future growth in per capital, real income, employment, and output (King and Levine, 1993; Jayaratne and Strahan, 1996; Levine and Zervos, 1998; Rajan and Zingales, 1998; Beck et al., 2000; Beck and Levine, 2002; Black and Strahan, 2002).

[9]Capital controls can be administrative or market-based measures. Administrative controls include outright prohibitions on foreign borrowing or lending, quantitative limits on these transactions, and the requirement that international capital transactions first receive government approval. Market-based measures include taxes on cross-border capital transactions, differential bank reserve requirements for resident and non-resident accounts, and the requirement that some proportion of capital inflows be deposited in a non-interest bearing account at a central bank (an unremunerated reserve requirement) which effectively serves as a tax on inflows. Unlike tariffs on goods and services, which are subject to the multilateral General Agreement on Tariffs and Trade (GATT), countries are generally free to remove or impose capital controls without reference to international agreements.

[10]This broad relationship between institutions and growth manifests itself through various channels. To name a few, poor institutions and corruption reduce foreign direct investment (Javorcik and Wei, 2009) and undermine incentives for domestic firms to reinvest their earnings (Cull and Xu, 2005), with negative implications for growth. A difficult business environment impedes the entry of new firms to the market (Bruno et al., 2011), which is in turn an important driver of overall productivity growth. In countries with stronger contract

property rights, unhealthy business environment and ineffective rule of law- significantly increase uncertainty about financial returns on innovation, increase the cost of investment needed to develop new products and services and do not provide incentives to realize long-term and risky investments (Olson, 2000). As a result, physical and human capital cannot be employed effectively.

In addition to local factors, foreign innovation activity could also affect decisions of domestic R&D investments.[11] Foreign knowledge can bring in advanced foreign technology, managerial skills, and other know-how and by making domestic markets more competitive through the trade of technological goods (*imports*), entry of foreign companies ($FDI$), and inflows of highly-skilled individuals ($InventorsInflows$).

More specifically, a rich research avenue, the trade-growth literature, infers technological learning by analyzing trade flows (Grossman and Helpman, 1991a; Coe and Helpman, 1995; Eaton and Kortum, 2001; Keller, 2002; Caselli and Wilson, 2004). Imports of foreign capital and intermediate goods allow a recipient country to learn from the R&D-, or 'technology'-content embodied in the traded good. Another, more recently explored, channel of knowledge diffusion is the mobility of highly skilled personnel.

Furthermore, an extensive literature (Glass and Sagg, 1998; Borensztein et al., 1998; Xu, 2000; van Pottelsberghe de la Potterie and Lichtenberg, 2001) has examined the various channels through which FDI inflows disseminate knowledge namely, imports of capital goods by the subsidiaries of multinational corporations, R&D flows carried out in the parent country, movements of employees/managers across countries, and the links between multinational corporations subsidiaries and local firms.

The mobility of highly-skilled individuals is another channel of knowledge diffusion. Patent inventors consist a specific class of workers that belong to the upper tail of the skills distribution who are deeply involved in the production of innovation and are important vehicle of knowledge circulation; when they move, knowledge moves with them and contributes to local innovation activity.[12]

The scientific nature of R&D is human capital intensive. Human capital is an important input in R&D and, therefore, increases labor productivity indirectly by accelerating tech-

enforcement, industries that rely on customized inputs and relation-specific investments grow faster (Nunn, 2007) as better contract enforcement facilitates the necessary investment. Countries with better economic institutions also specialize in more complex production processes in terms of number of various inputs required (Levchenko, 2007). More sophisticated exports can in turn be linked to better growth performance over the long-run (Hausmann et al., 2007).

[11] See Drivas et al. (2016) for a comprehensive review of the literature on different channels of international knowledge diffusion.

[12] See Miguelez et al. (2010) for an excellent survey of the literature, Ganguli (2015) for recent evidence on migration of researchers and diffusion of ideas and Drivas et al. (2018) on mobility and innovation.

nological change. (Mankiw et al., 1992; Romer, 1994; Aghion et al., 2009; Francesco and Streb, 2017). In addition, different types of human capital such as basic and higher education or training-on-the-job might play different roles in both production and innovation activities. A country with high number of people with tertiary education, scientists and engineers not only achieves higher levels of R&D investment but is also able to 'absorb' foreign advanced knowledge from abroad and benefit from the realization of R&D spillovers (Redding, 1996).

The set of social variables ($S$) contains measures of human capital, labour market rigidity and the sectoral composition of the economy. The scientific nature of R&D is human capital intensive. Human capital is an important input in R&D and, therefore, increases labor productivity indirectly by accelerating technological change. (Mankiw et al., 1992; Romer, 1994; Aghion et al., 2009; Francesco and Streb, 2017). In addition, different types of human capital such as basic and higher education or training-on-the-job might play different roles in both production and innovation activities. A country with high number of researchers not only achieves higher levels of R&D investment but is also able to 'absorb' foreign advanced knowledge from abroad and benefit from the realization of R&D spillovers (Redding, 1996). Rigid labor markets may lead to low productivity and innovation performance as they decrease labour turnover and consequently hampering 'job matches' and learning spillovers (Nickell and Layard, 1999), reduce incentives for taking innovative risks (Malcomson, 1997), do not enhance the inflow of new people with new ideas and new networks that may foster innovation. Employees may be entrenched in safe jobs, gradually losing their creativity. A high primary sector share increases the effect of reallocation impediments and thereby reduces the efficiency with which countries produce output and innovation (Temple, 2005; Vollrath, 2009). High-technology exporting performance is a good proxy for the technological capabilities of the countries and is expected to be positively correlated with innovative capacity. High-technology oriented exporting may involve some learning effects, due to exposures to international contacts with buyers and customers, which likely foster knowledge and technology spillovers, such as access to technical expertise, including new product designs and new production methods.[13]

Finally, the set $Z$ contains interaction terms of capital controls with financial development ($CA * FD$ and technology profile ($CA * HighTechExp$) to differentiate across different mechanisms and set ups.

[13]For instance, the purchase of an input requires some degree of customization or extended coordination between the seller and the buyer. Pack and Saggi (2001) develop a model in which the sellers have an incentive to provide technology to buyers, even if that technology may spill over to other sellers and buyers. Arguments on the benefits of international trade on economic growth and technology are best illustrated in the endogenous growth models offered by Young (1991), Grossman and Helpman (1991b), and Eicher (1999).

### Estimation Approach

We estimate equation (4.5) by using a variety of econometric methods, tests and data splits. We rely on methods incorporating country- and time-specific effects. At first, to draw out fixed-effects of the error term, we use dummies for both countries and years.[14] To address concerns regarding endogeneity in some variables and improve the efficiency of our estimators, we apply a two-step efficient GMM estimator using lagged levels dated between *t-3* and*t-6* as instruments of the endogenous variable ($R\&D_{t-1}$) with standard errors robust to heteroskedasticity and within-country serial correlation.

To assess instrument validity, we report a Hansen J-test of the null hypothesis that the over-identifying restrictions are valid, i.e. that instruments are exogenous. We further apply a Kleibergen-Paap rk LM test under the null hypothesis that the model is underidentified, i.e. the matrix is not full column rank. To test for weak instruments, we report Kleibergen-Paap rk Wald F-statistics compared to their respective critical values. In addition, a Durbin-Wu-Hausman test for the exogeneity of the endogenous regressors is also reported, where a rejection of the null hypothesis indicates that instrumental variable techniques are required. Finally, Arellano-Bond AR(1) to AR(3) tests for autocorrelation in the residuals are also applied under the null hypothesis of no autocorrelation.

## 4.3 Data Description and Analysis

Our empirical analysis is based on annual data from 54 countries for the period 1995-2013. A list of all countries is presented in Table 4.1, below. We necessarily focus only on countries that report R&D expenditures for the whole period of our investigation.

Our data come from a range of sources. Data on our dependent variable, R&D intensity (*R&D*) -defined as the ratio of R&D expenditure to GDP- come from the World Bank, *World Development Indicators* (WDI).

Information on our capital control index (*CA*) is derived from Fernandez et al. (2015a), who developed a new dataset of capital restrictions on both inflows and outflows of ten categories of assets for 100 countries over the period 1995 to 2013.[15] An attractive feature

[14] Roodman (2009) supports that it is usually wise to include time dummies to remove universal time-related shocks from the errors.

[15] Available at the NBER's International Finance and Macroeconomics Catalogue of Data Sources at http://www.nber.org/data/international-finance. Like other *de jure* capital control datasets, the Fernandez et al. (2015a) is based on information in IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) and builds on Schindler (2009), among other datasets, but it includes additional asset categories, more countries and a longer time period to existed databases. Other cross-country datasets that also based on the AREAER are the *CAPITAL* and $FINCURRENT$ indices of Quinn (1997) (first presented in 1997), the *KAOPEN* index of Chinn and Ito (2006) (first presented in 2006) and the *KA* index of Schindler (2009); all

Table 4.1: List of Countries

| *OECD* | *non − OECD* | *'Open'* | *'Wall'* | *'Episodic'* |
|---|---|---|---|---|
| *Australia* | *Argentina* | *Canada* | *China* | *Argentina* |
| *Austria* | *Brazil* | *Denmark* | *India* | *Australia* |
| *Belgium* | *Bulgaria* | *France* | *SriLanka* | *Austria* |
| *Canada* | *China* | *Greece* | *Tunisia* | *Belgium* |
| *CzechRepublic* | *Colombia* | *Ireland* | | *Brazil* |
| *Denmark* | *CostaRica* | *Italy* | | *Bulgaria* |
| *Finland* | *Cyprus* | *Japan* | | *Colombia* |
| *France* | *Ecuador* | *Latvia* | | *CostaRica* |
| *Germany* | *India* | *Netherlands* | | *Cyprus* |
| *Greece* | *Kuwait* | *NewZealand* | | *CzechRepublic* |
| *Hungary* | *Malaysia* | *Norway* | | *Ecuador* |
| *Iceland* | *Malta* | *Panama* | | *Finland* |
| *Ireland* | *Moldova* | *Spain* | | *Germany* |
| *Italy* | *Pakistan* | *Sweden* | | *Hungary* |
| *Japan* | *Panama* | *UK* | | *Iceland* |
| *KoreaSouth* | *Paraguay* | *Uruguay* | | *KoreaSouth* |
| *Latvia* | *Romania* | | | *Kuwait* |
| *Mexico* | *Russia* | | | *Malaysia* |
| *Netherlands* | *Singapore* | | | *Malta* |
| *NewZealand* | *SouthAfrica* | | | *Mexico* |
| *Norway* | *SriLanka* | | | *Moldova* |
| *Poland* | *Thailand* | | | *Pakistan* |
| *Portugal* | *Tunisia* | | | *Paraguay* |
| *Slovenia* | *Uruguay* | | | *Poland* |
| *Spain* | | | | *Portugal* |
| *Sweden* | | | | *Romania* |
| *Switzerland* | | | | *Russia* |
| *Turkey* | | | | *Singapore* |
| *UK* | | | | *Slovenia* |
| *USA* | | | | *SouthAfrica* |
| | | | | *Switzerland* |
| | | | | *Thailand* |
| | | | | *Turkey* |
| | | | | *USA* |

Division of countries into 'Open' (almost zero capital restrictions), 'Wall' (very high capital restrictions) and 'Episodic' (countries with a more transitory capital controls profile) follow IMF's categorization. For more details, see Klein (2012).

of this dataset is that it provides a level of asset disaggregation that allows a more detailed analysis of capital controls than with most other capital control indices.[16] More specifically, there is information on restrictions of capital inflows ($CA_{IN}$) and capital outflows ($CA_{OUT}$), as well as, detailed information on restrictions of ten different categories of assets: equities ($eq$), bonds ($bo$), money market instruments ($mm$), collective investments ($ci$), derivatives ($de$), financial credits ($fc$), direct investment ($di$), commercial credits ($cc$), guarantees, securities and financial backup facilities ($gs$), and real estate ($re$). Table A2 in the Appendix provides an analytical presentation of these assets. Figure 4.1 below depicts the development of (total) capital control index, in the left panel, and of capital outflows (dashed line) and inflows (bold line) in the right panel for all countries in our sample.

The developments of capital controls on outflows (dashed line) and inflows (bold line) are shown in the left panel of Figure 1, while in the right panel is the evolution of the restrictions on individual capital assets.

The restrictions on capital inflows and outflows are highly correlated (0.884) and show strong co-movement with the later to exhibit only higher volatility. Among the individual capital assets, it appears that real estate exhibit, on average, the highest restrictions whereas guarantees, securities and financial backup facilities the lowest. However, financial credits display the biggest volatility, while guarantees, securities and financial backup facilities the smallest.

To measure the level of financial development ($FD$) of a country, we employ a newly developed index constructed by the International Monetary Fund (IMF).[17] The index aims to display the multidimensional process of contemporary financial sector by capturing the key features of financial systems - depth (size and liquidity of markets), access (ability of individuals and companies to access financial services), and efficiency (ability of institutions

available at http://www.nber.org/data/international-finance. Additionally, there is the financial openness index $FOI$ by Johnston and Tamirisa (1998). See Quinn et al. (2011) for a comprehensive survey for a wide range of indicators on financial openness.

[16] An alternative way to measure financial integration is to use *de facto* measures, i.e., quantity-based measures that rely on actual flows. A widely used *de facto* indicator is the Lane and Milesi-Ferretti (2006, 2007) index $TOTAL$, which is calculated as a country's aggregate assets plus liabilities relative to its GDP. This measure includes portfolio equity, FDI, debt, and financial derivatives. *De facto* indicators are not free from limitations. An important one is the inconsistency of reporting and treating FDI across countries and over time. They may also fail to accurately reflect a government's policy stance. In addition, such measures do not capture the degree of enforcement of capital controls. See Kose et al. (2009) for a comparison between *de jure* and *de facto* indicators.

[17] Available at: https://www.imf.org/external/pubs/cat/longres.aspx?sk=43621.0. For a description, see, Svirydzenka, K., *Introducing a New Broad-based Index of Financial Development*, Strategy, Policy, and Review Department, IMF Working Paper, WP/16/5., 2016.


Figure 4.1: Development of R&D Activity and Capital Controls over the period 1995 - 2013

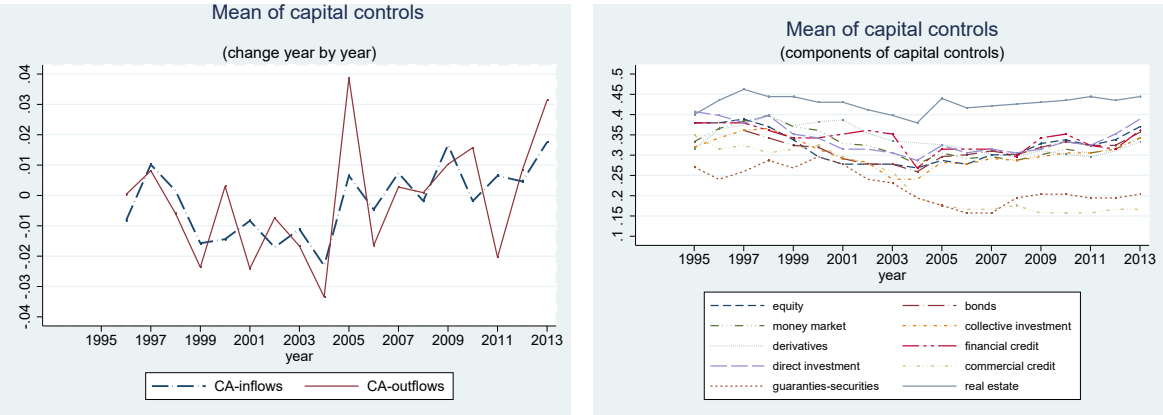


Figure 4.2: Developments of Capital Inflow, Outflow and Asset Restrictions

to provide financial services at low cost and with sustainable revenues, and the level of activity of capital markets).[18]

Information on the quality of economic institutions (*Institutions*) is derived from the World Bank, *Worldwide Governance Indicators* (WGI) database, which reports people's perceptions on six broad aspects of quality of governance - voice and accountability, political stability and absence of violence/terrorism, government effectiveness, regulatory quality, rule of law, and control of corruption.[19] For robustness, we employ all measures in our analysis as well as composite measures based on them.

Data on an economy's sectoral composition, proxied by the share of employment in agriculture (*AgricultureShare*), and countries' high-tech exporting performance ($HighTechExp$) are obtained from the WDI. From the same source, we also derive information of a country's social aspects relevant to innovation namely, high-skilled labor and labor market rigidity; the former is proxied by the number of researchers in the labor force (*ResearchersDensity*) and the latter by the long-term unemployment ratio ($Unemployment$).

Data on the three channels of international technology transfer considered here, namely ratio of inward FDI over GDP ($FDI$) and share of imports to GDP ($Imports$) come from the WDI, while information on the third one, the international mobility of high-skilled individuals, comes from the World Intellectual Property Organization (WIPO), which maps migratory patterns of (patent) inventors based on information contained in patent applications filed under the Patent Cooperation Treaty (PCT). The database contains bilateral counts of "migrant inventors" for a large number of years as well as a considerable number of "sending" and "receiving" countries. We construct inventors mobility inflows ($InventorInflows$) in a given country by counting the number of occurrences, i.e., the sum of flows of migrant inventors to a country from all other countries for every year.

Data on the main channel of R&D financing across borders, i.e. R&D funded from abroad in terms of total R&D per country, come from UNData. [20]. Since this variable is quite unbalanced, as reported above, we replace it by a dummy variable which splits countries between high (1) and low (0) dependent from external financing from abroad for R&D activities.

[18] Instead of relying on single indicators as proxies for financial development, the IMF has created a number of indices that summarize how developed financial institutions and financial markets are in terms of their depth, access, and efficiency. These sub-indices are aggregated into two higher level sub-indices, financial institutions and financial markets, which measure, respectively, how developed financial institutions and financial markets overall are. These two sub-indices are aggregated into the overall measure of financial development ($FD$). As any constructed index, this index may not be caveat-free. For one thing, the index is designed to capture only characteristics of financial systems (depth, access, efficiency) and does not include their underlying drivers (institutional, regulatory, and legal frameworks) or outcomes (financial stability measures).

[19] See http://info.worldbank.org/governance/wgi/#home for definitions and further details.

[20] See $http://data.un.org/Data.aspx?q=gerd\&d=UNESCO\&f=series\%3AST_SCGERDFA$

Finally, we cut the data in various ways to allow for potential non-linear effects in our model and, therefore, include some interaction terms, namely $CA * FD$, $CA * Institutions$, $CA * HighTechExp$ and $CA * ExternalDependence$. Table 4.2 below provides summary statistics of the variables in our model:

Table 4.2: Summary Statistics, 1995-2013

| variables | Observations | Mean | St. Dev. | Min | Max |
|---|---|---|---|---|---|
| *R&D* | 972 | 1.22 | 0.95 | 0.05 | 4.15 |
| *CA* | 972 | 0.32 | 0.33 | 0 | 1 |
| $CA_{IN}$ | 1,026 | 0.29 | 0.32 | 0 | 1 |
| $CA_{OUT}$ | 1,026 | 0.34 | 0.37 | 0 | 1 |
| $FD$ | 1,134 | 0.51 | 0.23 | 0.07 | 1 |
| *Institutions* | 972 | 0.73 | 1.06 | -1.45 | 2.59 |
| *ResearchersDensity* | 972 | 0.43 | 0.36 | 0.01 | 1.59 |
| *AgricultureShare* | 1.134 | 14.89 | 15.77 | 0.13 | 69.30 |
| *HighTechExp* | 1,104 | 3.764 | 8.042 | 0.001 | 67.12 |
| *Unemployment* | 1.134 | 7.84 | 4.64 | 0.49 | 27.47 |
| *Imports* | 972 | 43.16 | 28.92 | 8.40 | 210.41 |
| $FDI$ | 965 | 6.17 | 24.61 | -43.46 | 451.72 |
| *InventorInflows* | 1,080 | 4.32 | 14.01 | 0 | 133.96 |
| *ExternalDependence* | 1,092 | 0.35 | 0.48 | 0 | 1 |

Note: *R&D*, $FDI$, *Imports* and *HighTechExp* are all ratios (of GDP); *CA* is an IMF-constructed index of financial capital restrictions (ranges from 0 to 1; where 0 denotes open to international finance economies and 1 closed (wall) economies); $FD$ is an IMF-constructed index of financial development (ranges from 0 to 1; where 1 shows highly developed countries); *Institutions* is an index of institutional quality (corruption index, here; higher values correspond to less corrupted countries); *ResearchersDensity* is the ratio of researchers over labor force; *AgricultureShare* is ratio of employment in agriculture and manufacturing, respectively, to total employment; *Unemployment* is a ratio (unemployed to labor force); *InventorInflows* is occurrence (non-negative integer); *ExternalDependence* is a dummy variable (1 refers to countries with the highest external financing dependence for R&D expenditures.

Countries spend, on average, 1.2% of their GDP on R&D investment, with Paraguay to spend the least on R&D (0.07%) in our sample, while Finland and Sweden the highest (3.2%). Further, less than a quarter of the countries in our sample invest more than 2% of their GDP in R&D expenditures, while R&D expenditures, on average, climbed more than 40%, over our sample period. On average, countries are rather open to free mobility of international capital as the index of capital controls is about 0.3 with more restrictions set on capital outflows (0.32) than on inflows (0.29). The level of financial development is fair (0.51) and the quality of governance (reflected on corruption index) is, on average, in the middle of the distribution. There is a wide heterogeneity in the sectoral production distribution across countries as employment in agriculture and countries' high-tech exports

indicate. Researchers, on average, account for 0.43% of labor force. During the period of our investigation, countries are rather open in terms of trade (imports account about 43% of GDP), but there is no much FDI (on average, about 6% of GDP) and inventor mobility (on average, there are only 4 inventors that move into a country per year) among them.

## 4.4 Empirical Results

This section presents the results. We first examine the importance of capital controls on innovation. Then, we proceed to explore what particular controls, across different asset categories, matter the most for innovation activity. We complete the section by presenting robustness analysis.

### 4.4.1 Do Capital Controls Matter for Innovation?

Table 4.3 below summarizes estimates of equation (4.5). Columns (1) and (2) present OLS estimates for a specification without (column (1)) and with (column (2)) interaction terms. The latter, allows one to explore the range of different effects of capital controls given a country's profile. To address potential endogeneity issues, columns (3) and (4) present GMM estimates following the rationale of columns (1) and (2), respectively. The rest of the columns delve into specific issues. Specifically, column (5) re-estimates specification in column (4) but only for a sub-sample of countries, the so-called 'episodic' to explore whether results alter for this particular set of countries with transitory capital controls. Further, capital controls may have a different effect on R&D activity depending on whether they are imposed on capital inflows or outflows. Columns (6) and (7) re-estimate specification in column (4) for capital inflow ($CA_{IN}$) and outflow ($CA_{OUT}$) restrictions, respectively. To control for country- and time-related effects, all specifications include country-year fixed effects and robust standard errors; t-values are reported in parentheses.

We begin with analyzing OLS estimates of column (1). The coefficient of our interest is that of capital controls ($CA$) and reads as follows: a unit of decimal increase (for example, from 0.1 to 0.2) in the capital control index associates with a negative change in R&D spending by about 8% [ $e^{0.1*(-0.081)} - 1$]. All the remaining variables carry the expected sign. For example, a higher past technological effort ($R\&D_{t-1}$) is strongly correlated with present innovation activity, as a one per cent increase of past R&D expenditure associates with an increase of about 84% of current R&D spending. Prompted by the extensive discussion in the literature, we include the index of corruption, as a control for governance institutional quality ($Institutions$) (Mauro, 1995; Meon and Sekkat, 2005; Swaleheen, 2011)

and find that reduction of corruption is positively correlated with local R&D activity; a finding in line with the literature (Veracierto, 2008; Paunov, 2016; Gang and Yano, 2017).[21] All coefficients of social and structural composition variables are in accordance with the literature (Rodríguez-Pose and Cataldo, 2014). We find that as the number of researchers in the labor force (*ResearchersDensity*) increases and the employment in the agricultural sector (*AgricultureShare*) decreases, the innovation activity increases. Labor market rigidity and high-tech exporting performance despite the expected negative and positive signs, respectively, are of no statistical significance. Finally, all channels of international technology transmission, i.e., foreign direct investment ($FDI$), mobility of inventors ($InventorInflows$) and merchandise trade ($Imports$), are statistically insignificant. Finally, the R&D that comes from abroad ($ExternalDependence$) has positive but statistically insignificant effect on domestic innovation activity.

Countries, however, have specific profiles depending on their financial system, technology, institutional quality and external financing of their R&D activity. Such differences may mask important variations on the 'average' effect of capital restrictions on countries' innovation activity documented in column (1). To address this issue, we re-estimate specification in column (1) including this time interaction terms. Results, shown in column (2), reveal a different picture. The total impact of *CA* on R&D is now almost three times larger compared to that documented in column (1). We find that high level of both financial development and quality of institutions smooth out the negative consequences of capital controls, while strong high-tech exporting profile and high dependence on externally financing R&D exacerbate the negative effect. Quality financial and governance institutions facilitate companies to fund their research even in harsh financial conditions (Brown et al., 2009; Ayyagari et al., 2011; Brown et al., 2012; Hsu et al., 2014) and therefore tend to ameliorate the size of the negative effect of capital frictions; however, their effect is not statistically significant. In contrast, the more high-technology export oriented an economy is, the higher the negative impact of the capital controls. The reason is that capital frictions could pose strain to the technological capabilities and innovation potential of a firm, and, therefore, economies which heavily rely on advanced technology exporting goods may underperform under restrictive financial conditions. Similarly, the higher the dependency of a country in financing its innovation from abroad, the larger the impact of capital restrictions is. This finding comes as no surprise:

[21] For example, Veracierto (2008) denotes that corruption can lower the rate of product innovation in an industry and, as a result, it lowers the growth rate of an economy. Paunov (2016), by using firm level data for 48 developing and emerging countries, shows that corruption affects small firms and lowers machinery investments for innovation. Gang and Yano (2017) also find that stronger anti-corruption efforts make firms more likely to acquire external funds, invest significantly more in R&D and generate more patents.

Table 4.3: Innovation and Capital Controls

| | OLS | | GMM | | | | |
|---|---|---|---|---|---|---|---|
| | All | All | All | All | Episodic | $CA_{IN}$ | $CA_{OUT}$ |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $lnR\&D_{t-1}$ | 0.838*** | 0.830*** | 0.614*** | 0.599*** | 0.646*** | 0.582*** | 0.601*** |
| | [28.004] | [27.765] | [10.001] | [9.734] | [10.594] | [9.938] | [9.757] |
| $CA$ | -0.084*** | -0.084 | -0.080* | -0.252* | -0.083 | -0.174 | -0.235** |
| | [-3.278] | [-1.258] | [-1.779] | [-1.916] | [-0.536] | [-1.146] | [-2.420] |
| $FD$ | 0.100 | 0.050 | 0.303*** | 0.190* | 0.363** | 0.194 | 0.212** |
| | [1.100] | [0.544] | [2.656] | [1.677] | [2.204] | [1.601] | [1.972] |
| $Institutions$ | 0.082*** | 0.073*** | 0.037 | 0.045* | 0.068** | 0.023 | 0.057** |
| | [3.950] | [3.433] | [1.508] | [1.771] | [2.120] | [0.884] | [2.322] |
| $ResearchersDensity$ | 0.111* | 0.123** | 0.480*** | 0.464*** | 0.446*** | 0.428*** | 0.492*** |
| | [1.863] | [2.064] | [5.359] | [5.538] | [4.591] | [5.307] | [5.729] |
| $HighTechExp$ | -0.002 | 0.001 | -0.002 | 0.006 | 0.009 | 0.007* | 0.003 |
| | [-0.644] | [0.301] | [-0.599] | [1.218] | [1.502] | [1.763] | [0.689] |
| $AgricultureShare$ | -0.003** | -0.004** | -0.005** | -0.004* | -0.001 | -0.005** | -0.004* |
| | [-2.067] | [-2.174] | [-2.405] | [-1.715] | [-0.366] | [-2.036] | [-1.673] |
| $Unemployment$ | 0.000 | 0.000 | -0.001 | 0.001 | -0.001 | 0.000 | 0.000 |
| | [0.053] | [0.046] | [-0.286] | [0.257] | [-0.268] | [0.228] | [0.148] |
| $ExternalDependence$ | 0.037 | 0.073 | -0.034 | 0.068 | 0.307** | 0.121 | 0.027 |
| | [0.451] | [0.907] | [-0.352] | [0.632] | [2.339] | [1.047] | [0.265] |
| $Imports$ | 0.001 | 0.001 | 0.002* | 0.001 | -0.000 | 0.001 | 0.001 |
| | [0.996] | [0.471] | [1.804] | [0.861] | [-0.037] | [0.939] | [1.071] |
| $FDIinflows$ | 0.000 | -0.000 | 0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| | [0.325] | [-1.230] | [0.768] | [-0.911] | [-1.468] | [-0.972] | [-0.452] |
| $Inventorinflows$ | -0.179 | -0.009 | 0.344 | 0.436* | 0.311 | 0.518** | 0.419* |
| | [-0.960] | [-0.046] | [1.404] | [1.856] | [1.286] | [2.271] | [1.659] |
| $CA*FD$ | | 0.215 | | 0.622*** | 0.345 | 0.554** | 0.548*** |
| | | [1.507] | | [2.740] | [1.323] | [2.266] | [2.866] |
| $CA*HighTechExp$ | | -0.010* | | -0.024*** | -0.026** | -0.028*** | -0.017* |
| | | [-1.686] | | [-2.807] | [-2.350] | [-4.008] | [-1.867] |
| $CA*Institutions$ | | 0.050 | | 0.107* | 0.153* | 0.223*** | 0.012 |
| | | [1.236] | | [1.774] | [1.857] | [2.869] | [0.272] |
| $CA*ExternalDependence$ | | -0.193** | | -0.319*** | -0.361*** | -0.597*** | -0.131* |
| | | [-2.516] | | [-2.909] | [-2.720] | [-3.662] | [-1.833] |
| **Total effect of CA** | **-0.084** | **-0.231** | **-0.08** | **-0.263** | **-0.346** | **-0.253** | **-0.148** |
| Observations | 821 | 821 | 569 | 569 | 362 | 569 | 569 |
| R-squared | 0.894 | 0.897 | 0.872 | 0.879 | 0.883 | 0.881 | 0.875 |
| Kleibergen-Paap rk LM | - | - | 0.002 | 0.004 | 0.037 | 0.001 | 0.004 |
| Kleibergen-Paap rk Wald (F statistic) | - | - | 26.696 | 25.581 | 52.126 | 26.889 | 26.282 |
| Arellano-Bond for AR-1 (p-value) | - | - | 0.123 | 0.17 | 0.222 | 0.138 | 0.158 |
| Arellano-Bond for AR-2 (p-value) | - | - | 0.517 | 0.594 | 0.809 | 0.768 | 0.51 |
| Arellano-Bond for AR-3 (p-value) | - | - | 0.318 | 0.346 | 0.26 | 0.215 | 0.37 |
| Hansen $J$-test (p-value) | - | - | 0.336 | 0.424 | 0.110 | 0.411 | 0.383 |
| Durbin-Wu-Hausman (p-value) | - | - | 0.001 | 0.001 | 0.011 | 0.001 | 0.001 |

Dependent variable is log of R&D share to GDP; (*), (**), (***) are significance level at the 10%, 5% and 1%, respectively. Robust standard errors and country and year fixed effects are included; *t*-values are reported in parentheses; Diagnostics: Kleibergen-Paap rk LM statistic tests whether the estimated equation is underidentified (null); Kleibergen-Paap rk Wald F statistic tests whether instruments are weak (null) with critical values 5.34 to 24.58; Arellano-Bond for AR(1) to AR(3) tests whether there is no autocorrelation (null); Durbin-Wu-Hausman tests whether instrumental variables techniques are required (null); and Sargan-Hansen tests whether instruments are valid (null). Lagged values of R&D from *t-3* to *t-6* are used as instruments.

when the R&D activity depends heavily on capital flows from abroad, any restriction in the flow of capital has higher impact on domestic R&D.

A common concern, however, when dealing with policy variables and economic outcomes is endogeneity. Innovation may be determined by certain policies (e.g. capital controls) and institutions, but such factors may, in turn, be affected by the innovative capacity of a country. We address endogeneity concerns with GMM and an instrumental variable estimation. We opt for a two-step efficient GMM estimator applying country and year fixed effects. Our model is estimated in levels where our instruments are less than the number of countries and thus, avoiding a weak Sargan test. Besides, by using system GMM, a great number of instruments is usually used, both in levels and in differences (see Arellano & Bond, 1991 and Arellano & Bover, 1995) for estimation, with difference GMM or system GMM under the basic assumption of T(time) small and N (individuals) large. Several precautions are taken in order to avoid the problem of instrument proliferation. Tests reported at the bottom of Table 4.3 clearly show that our instruments are exogenous (Hansen J-test) and they do not suffer from weak identification problem (Kleibergen-Paap rk Wald F-statistic). Further, the instrumental variable technique is necessary (Durbin-Wu-Hausman test) while our model is not underidentified (Kleibergen-Paap rk LM test) and does not suffer from first to third order serial correlation (Arellano-Bond for AR(1) to AR(3) tests). The specifications presented in column (3) and (4) are conceptually analogous to specifications (1) and (2), respectively.

One can note that the statistically significant variables still pertain their significance and estimates are quite similar in size compared to those in columns (1) and (2). Notable exception is the coefficient of the endogenous regressor ($R\&D_{t-1}$), which is now smaller. Further, all interaction terms are now statistical significant. At the data means, the marginal effect is negative and on average -0.263; ranging from -0.62 for the least developed country (Paraguay) to 0.44 for the highly financial developed country (Switzerland) and from -0.81 for the most high-tech (Singapore) to 0.05 for the least high-tech exporting (Kuwait) country and finally ranging from -0.62 for the most corrupted country (Paraguay) to 0.38 for the least corrupted (Denmark) country in our sample. Finally, the group of countries that are highly dependent in financing their R&D from abroad have a marginal effect, on average, on the R&D investment -0.26 while the other group has an effect 0.06.

Thus far, we examined all countries in our sample. While some countries have long-standing capital controls, other re-introduced controls when events seem to warrant their use. These episodic controls, transitory and targeted towards particular categories of assets, may make them less distortionary and inefficient than broad, long-standing controls (Klein, 2012). To explore this issue, and as a further robustness of our results, we focus only on countries

with episodic controls. Column (5) presents these estimates. Our results support that the overall marginal effect of capital controls is much higher than that of the whole sample.[22]

We finally ask whether restrictions of capital inflows have different impact on innovation activity than restrictions on the outflows. Controls in capital inflows which serve as a preventive tool of potential vicissitudes of macroeconomic variables are not usually applied, whereas restrictions on capital outflows are rather tool of the very last resort and common across countries. We therefore examine separately their effect on R&D. Estimates in columns (6) and (7) reveal that both types of restrictions have a negative effect on innovation with the effect of capital inflows restrictions to be more than 1.5 times larger than that of outflows [23]

Summing up, capital controls, on average, appear to have a negative effect on domestic R&D, varying depending on a country's profile namely the level of financial development, the quality of institutions, the technology performance and the financing dependence of R&D activities from abroad. High level of development in the financial sector and the quality of institutions smooth out some of the adverse effects of capital restrictions on R&D investment. Therefore, strengthening the quality and efficiency of the institutions could shield an economy against negative shocks caused by capital controls. In implementing capital restrictions, policy makers should be more cautious with countries characterized by high-tech export orientation as high technology firms could be either nascent (start-ups) or established -but performing substantial innovation- and therefore could be more sensitive to finance availability restrictions in order to advance their technology and remain competitive. Firm-level data could further shed more light as to what type of firms and sectors are more vulnerable to capital frictions. Further, high external dependence for financing R&D investment enlarges the impact of capital restrictions on R&D activity. Finally, the choice on whether restrictions should be imposed on capital inflows or outflows also has different implications on the R&D and consequently on a country's economic growth.

### 4.4.2 What Asset Restrictions Matter the Most for Innovation?

In this session, we proceed with estimating restrictions on different capital assets and their association with R&D investment. In doing so, in place of total capital controls index ($CA$) in equation (4.5), we put restrictions on its ten sub-components (Fernandez et al., 2015a), namely restrictions on equity ($eq$), bonds ($bo$), money market instruments ($mm$), collective investments ($ci$), derivatives ($de$), financial credits ($fc$), direct investments ($di$), commercial

[22] We also tested our model for non-episodic countries for which we found an insignificant impact of capital controls on R&D. Results, not reported here for brevity, are available upon request.

[23] The IMF (2012) reports that over the past decade only a few countries have tightened capital controls on outflows to address large or sudden capital outflows; Klein (2012) discusses that, after the Great Recession, emerging and developed countries started to impose new controls on capital inflows.

credits (*cc*), guaranties and-securities (*gs*) and real estate (*re*).[24] Table 4.4 below summarizes the results.

As one can note, results vary considerably across different asset categories. Tests reported at the bottom of Table 4.4 clearly show that our instruments are exogenous (Hansen J-test) and do not suffer from weak identification problem (Kleibergen-Paap rk Wald F-statistic). Further, the instrumental variables technique is necessary (Durbin-Wu-Hausman test) while our model is not underidentified (Kleibergen-Paap rk LM) and does not suffer from first to third order serial correlation.

Calculating the total marginal effect of capital controls for each asset category (last row of Table 4.3), we find that restrictions on commercial credit (*cc*) appear to have the largest, by far, negative association (-0.311) with R&D investment. The main characteristic of this type of asset is that typically is issued to raise short-term capital through which firms can immediately finance their obligations and activities such as international trade transactions or rendering of international services; therefore, commercial credit restrictions harm the financing of innovation. A country's profile, as the interaction term indicate, significantly relates to the severeness of the negative outcome. Countries that are more high-tech export oriented and rely more on financing their R&D from abroad face greater impediment on their innovation performance due to commercial credit restrictions compared to peers that do not exhibit this profile.

Further, restrictions on bonds (*bo*), collective investment (*ci*) and direct investments (*di*) also exert a negative impact, ranging from -0.233 to -0.222 on innovation activity. Restrictions on guaranties and securities have a milder impact. Hardly any association is documented between R&D spending and restrictions on equities (*eq*), money market instruments (*mm*), derivatives (*de*), financial credits ($fc$) and real estate (*re*). The reason is that any restriction on secondary market assets (i.e., equity, derivatives) does not exert directly any effect on the cash balances of a company -the company does not receive money when stock is traded in the secondary market but only from the primary market (initial public offering)- and, consequently, on company's innovation activity. Such restrictions rather influence the flow of assets among the investors and perhaps indirectly the stock value of the company in the future. Furthermore, money market instruments are tools for financing a company's current account and therefore restrictions on them have little to do with financing R&D activity.

Overall, we find that restrictions on high-volume, international transactions and easy-to-access funding (i.e., commercial credits) have the largest negative association with R&D performance compared to restrictions on secondary market assets (i.e., equity, derivatives) or assets that do not relate directly to a company's R&D funding (i.e., money market instruments,

[24] See Table A.1 in the Appendix for definitions of these assets.

Table 4.4: Controls Across Different Asset Categories

| | eq | bo | mm | ci | de | fc | di | cc | gs | re |
|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| $ln(R\&D_{t-1})$ | 0.617*** | 0.612*** | 0.608*** | 0.617*** | 0.620*** | 0.608*** | 0.613*** | 0.554*** | 0.590*** | 0.618*** |
| | [10.581] | [10.125] | [9.660] | [10.256] | [9.964] | [9.564] | [10.745] | [9.354] | [10.356] | [10.126] |
| $CA$ | -0.149 | 0.004 | -0.148* | -0.128 | -0.024 | -0.141** | -0.041 | -0.329*** | -0.080 | -0.023 |
| | [-1.494] | [0.041] | [-1.930] | [-1.156] | [-0.394] | [-2.448] | [-0.476] | [-4.038] | [-0.652] | [-0.184] |
| $FD$ | 0.231** | 0.297*** | 0.264** | 0.260** | 0.359*** | 0.225** | 0.305** | 0.253** | 0.283*** | 0.362*** |
| | [2.109] | [2.726] | [2.201] | [2.302] | [3.358] | [2.136] | [2.536] | [2.388] | [2.671] | [2.714] |
| $Institutions$ | 0.040* | 0.031 | 0.049** | 0.023 | 0.033 | 0.066** | 0.027 | 0.045 | 0.064** | 0.031 |
| | [1.682] | [1.268] | [1.989] | [0.921] | [1.408] | [2.507] | [1.170] | [1.621] | [2.421] | [1.195] |
| $ResearchersDensity$ | 0.468*** | 0.436*** | 0.473*** | 0.473*** | 0.495*** | 0.456*** | 0.437*** | 0.480*** | 0.508*** | 0.467*** |
| | [5.745] | [5.312] | [5.255] | [5.381] | [4.904] | [5.430] | [5.899] | [5.627] | [6.127] | [5.420] |
| $HighTechExp$ | 0.000 | 0.000 | 0.003 | 0.001 | -0.003 | 0.008 | 0.003 | 0.003 | -0.001 | -0.002 |
| | [0.070] | [0.053] | [0.600] | [0.353] | [-1.083] | [1.392] | [0.936] | [0.733] | [-0.252] | [-0.505] |
| $AgricultureShare$ | -0.005** | -0.005** | -0.004** | -0.005** | -0.005** | -0.004* | -0.005** | -0.003 | -0.005** | -0.005** |
| | [-2.042] | [-2.173] | [-2.059] | [-2.076] | [-2.192] | [-1.847] | [-1.990] | [-1.452] | [-2.309] | [-2.488] |
| $Unemployemnt$ | -0.001 | -0.000 | -0.000 | -0.001 | -0.001 | 0.001 | -0.000 | 0.001 | -0.001 | -0.000 |
| | [-0.299] | [-0.171] | [-0.133] | [-0.397] | [-0.372] | [0.321] | [-0.230] | [0.288] | [-0.289] | [-0.226] |
| $ExternalDependence$ | 0.014 | 0.005 | -0.004 | -0.002 | -0.021 | 0.012 | -0.013 | 0.088 | -0.037 | -0.074 |
| | [0.129] | [0.044] | [-0.041] | [-0.020] | [-0.194] | [0.123] | [-0.118] | [0.856] | [-0.354] | [-0.647] |
| $Imports$ | 0.002 | 0.002* | 0.001 | 0.002* | 0.002** | 0.001 | 0.002** | 0.002** | 0.002* | 0.002** |
| | [1.637] | [1.676] | [0.924] | [1.692] | [2.385] | [0.837] | [2.060] | [2.158] | [1.796] | [1.995] |
| $FDIinflows$ | 0.000 | 0.000 | -0.000 | 0.000 | 0.000 | -0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | [0.493] | [0.323] | [-0.767] | [0.344] | [0.785] | [-1.054] | [0.153] | [0.405] | [0.558] | [0.910] |
| $Inventorinflows$ | 0.418* | 0.380* | 0.307 | 0.399* | 0.512** | 0.405 | 0.487** | 0.643** | 0.692*** | 0.392* |
| | [1.809] | [1.694] | [1.201] | [1.654] | [2.121] | [1.628] | [2.187] | [2.454] | [2.851] | [1.706] |
| $CA*FD$ | 0.323 | 0.155 | 0.319* | 0.290 | 0.070 | 0.377*** | 0.153 | 0.626*** | 0.527* | -0.001 |
| | [1.622] | [0.799] | [1.946] | [1.462] | [0.561] | [3.185] | [0.881] | [3.632] | [1.898] | [-0.004] |
| $CA*HighTechExp$ | -0.005 | -0.009 | -0.016** | -0.014** | 0.001 | -0.018** | -0.024*** | -0.016*** | -0.011** | -0.002 |
| | [-1.378] | [-1.518] | [-2.367] | [-2.078] | [0.164] | [-2.399] | [-5.767] | [-3.700] | [-2.155] | [-0.861] |
| $CA*Institutions$ | 0.022 | 0.066 | 0.030 | 0.052 | 0.004 | -0.007 | 0.069** | 0.110* | 0.053 | 0.010 |
| | [0.567] | [1.457] | [0.609] | [1.375] | [0.130] | [-0.234] | [2.437] | [1.729] | [0.936] | [0.280] |
| $CA*ExternalDependence$ | -0.098 | -0.233** | -0.097 | -0.173** | -0.006 | -0.074 | -0.182*** | -0.325*** | -0.345*** | -0.032 |
| | [-1.484] | [-2.053] | [-1.371] | [-2.407] | [-0.095] | [-1.523] | [-3.187] | [-3.025] | [-3.162] | [-0.593] |
| **Total effect of CA** | **-** | **-0.233** | **-0.044** | **-0.226** | **-** | **-0.015** | **-0.222** | **-0.311** | **-0.115** | **-** |
| Observations | 569 | 569 | 569 | 569 | 560 | 569 | 569 | 569 | 569 | 569 |
| R-squared | 0.873 | 0.873 | 0.878 | 0.877 | 0.818 | 0.879 | 0.876 | 0.884 | 0.880 | 0.872 |
| Kleibergen-Paap rk LM (p-value) | 0.002 | 0.002 | 0.004 | 0.002 | 0.011 | 0.004 | 0.003 | 0 | 0.001 | 0.001 |
| Kleibergen-Paap rk Wald (F statistic) | 27.016 | 27.201 | 24.764 | 26.294 | 21.414 | 24.925 | 29.059 | 28.305 | 27.936 | 26.141 |
| Arellano-Bond for AR-1 (p-value) | 0.161 | 0.154 | 0.133 | 0.136 | 0.136 | 0.138 | 0.219 | 0.06 | 0.113 | 0.135 |
| Arellano-Bond for AR-2 (p-value) | 0.652 | 0.621 | 0.454 | 0.694 | 0.707 | 0.483 | 0.623 | 0.659 | 0.657 | 0.586 |
| Arellano-Bond for AR-3 (p-value) | 0.362 | 0.324 | 0.372 | 0.294 | 0.323 | 0.362 | 0.329 | 0.079 | 0.171 | 0.311 |
| Hansen $J$-test (p-value) | 0.253 | 0.268 | 0.444 | 0.390 | 0.258 | 0.248 | 0.306 | 0.286 | 0.278 | 0.288 |
| Durbin-Wu-Hausman (p-value) | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 | 0.001 | 0.001 |

Dependent variable is log of R&D share to GDP; (*), (**), (***) are significance level at the 10%, 5% and 1%, respectively. Robust standard errors and country and year fixed effects are included; *t*-values are reported in parentheses; Diagnostics: Kleibergen-Paap rk LM statistic tests whether the estimated equation is underidentified (null); Kleibergen-Paap rk Wald F statistic tests whether instruments are weak (null) with critical values 5.34 to 24.58; Arellano-Bond for AR(1) to AR(3) test whether there is no autocorrelation (null); Durbin-Wu-Hausman tests whether instrumental variables techniques are required (null); and Sargan-Hansen tests whether instruments are valid (null). Lagged values of R&D from *t-3* to *t-6* are used as instruments.

real estate). The profile of the country emerges strong in almost all cases: high-technology export-orientation and external R&D financing dependent countries appear to experience even greater negative effects on their R&D activity from capital asset restrictions. Institutional quality and a well functioning financial sector ameliorate, however, some of negative effects in all types of capita asset restrictions.

## 4.5 Conclusion

The recent financial crisis has rejuvenated the debate about the free moves of capital. Controls on capital flows have been receiving increasing support in policy circles, among researchers, and in the general economic debate. Theoretical research provides rationales for the imposition of episodic controls at the time of surging capital inflows, or at a time when the economy is booming.

This chapter offers novel insights on the effects of capital controls on innovation activity. To unfold the effects of capital controls on innovation, we employ a new data set that differentiates between controls on inflows and on outflows as well as among different asset categories allowing a more detailed analysis than with most other capital control databases and indices. Furthermore, we explore how the effects may vary across different institutional settings and technology performances. The chapter aims to contribute to evolving debate on the effects of international capital controls -through the financing of R&D- on economic growth.

Our results corroborate to a negative effect, on average, of capital controls on domestic R&D; however, their effect may vary depending on the level of financial development and technology of a country. High level of development in the financial sector smooths out some of the adverse effects of capital restrictions on R&D. Therefore, strengthening the quality and the efficiency of the financial institutions could shield an economy against negative shocks caused by capital controls. In implementing capital restrictions, policy makers should be more cautious for countries with high-tech export orientation as technology firms could be more vulnerable to finance availability restrictions in order to advance their technology and remain competitive.

Firms-level data could shed more light as to what sectors are more vulnerable to capital frictions. Finally, the choice on whether restrictions should be imposed on capital inflows or outflows may also have different implications on the R&D and consequently on economic growth.

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# Appendix A

Table A.1: Variable Names and Definitions

| Variables | Definition |
|---|---|
| Dependent Variable: | |
| *Underpricing* | First day return is the difference between the closing price and offer price divided by offer price. Data provided from CRISP. |
| Treatment Variables: | |
| *TMGranted* | Dummy variable set to 1 for firms with at least one Trademark (TM) before the IPO procedure, else 0. |
| *TMFiled* | Dummy variable set to 1 for firms with at least one Trademark (TM) before the IPO procedure, else 0. |
| *TMsBetwen1and2* | Dummy variable that takes the value of 1 if the firm has been issued between one and two TMs before IPO and 0 otherwise. |
| *TMsBetwen3and8* | Dummy variable that takes the value of 1 if the firm has been issued between three and eight TMs before IPO and 0 otherwise. |
| *TMsMoreThan8* | Dummy variable that takes the value of 1 if the firms has been issued more than 8 TMs before IPO and 0 otherwise. |
| Control Variables: | |
| *FirmAge* | The number of years from the firm's initial incorporation to the IPO date. This information is acquired from Field-Ritter database. |
| *Overhang* | The ratio of shares retained by the old shareholders divided by the shares issued. |
| *Proceeds* | Amount of money equal to the number of shares issued times the offer price. |
| Revisions | Change of the IPO offer price from the midpoint of the initial filing price range. |
| *Earnings* | Dummy variable that takes the value of 1 if the year prior to the IPO the firm discloses earnings and 0 otherwise. |
| *Leverage* | The ratio of total liabilities to total assets in the year before the IPO. |
| *UnderwriterRank* | Dummy variable that takes the value of 1 for Underwriters of with rank greater than eight as provided in the Loughran and Ritter (2004) database and 0 otherwise. |
| *Internet* | Dummy variable that takes the value of 1 for firms that are classified by Thomson Financial SDC as operating with internet in their business description. This information is drawn via the terms 'Internet', 'Online', 'eBusiness', 'eCommerce'. |
| *Technology* | Dummy variable that takes the value of 1 for firms with SIC codes 3571, 3572, 3575, 3577, 3578 ,3661, 3663, 3669, 3671, 3672, 3674, 3675, 3677, 3678, 3679 ,3812, 3823, 3825, 3826, 3827, 3829 ,3841, 3845, 4812, 4813 ,4899, 7371, 7372, 7373, 7374, 7375, 7378 else 0. |
| *Nasdaq* | Dummy variable that takes the value of 1 to 1 for NASDAQ-listed firms, else 0. |

This table describes in detail the all variables.

Table A.2: Correlation Table

| | ESG_disclose | Crisis | Overhang | Revisions | Leverage | Nasdaq | Earnings | Internet | Underwriter | Proceeds |
|---|---|---|---|---|---|---|---|---|---|---|
| ESG_disclose | 1.0000 | | | | | | | | | |
| Crisis | -0.018 | 1.000 | | | | | | | | |
| Overhang | 0.097 | -0.032 | 1.000 | | | | | | | |
| Revisions | 0.066 | 0.005 | 0.071 | 1.000 | | | | | | |
| Leverage | -0.015 | -0.012 | -0.013 | -0.071 | 1.000 | | | | | |
| Nasdaq | -0.185 | -0.025 | -0.009 | -0.094 | 0.059 | 1.000 | | | | |
| Earnings | 0.111 | 0.142 | 0.05 | 0.069 | 0.025 | -0.211 | 1.000 | | | |
| Internet | 0.008 | 0.018 | 0.083 | 0.088 | -0.020 | 0.024 | 0.014 | 1.000 | | |
| UnderwriterRank | 0.186 | 0.086 | 0.046 | 0.161 | -0.089 | -0.340 | 0.110 | 0.131 | 1.000 | |
| Proceeds | 0.301 | 0.060 | -0.158 | 0.214 | -0.089 | -0.460 | 0.154 | 0.022 | 0.484 | 1.000 |
| FirmAge | 0.141 | 0.145 | 0.007 | -0.030 | -0.019 | 0.062 | 0.006 | 0.049 | 0.022 | 0.019 |

Notes: Notes: This table reports pairwise correlations of variables used in the study. The sample includes 854 U.S. IPOs announced between 2008 and 2018. IPO deals are retrieved from the Securities Data Company (SDC) Database with aftermarket and accounting data obtained from CRSP and Compustat databases, respectively. ESG_disclose data comes from the RepRisk database. All variables are defined in Appendix A.

Table A.3: Asset Categories of Capital Controls

| Asset category | Definition | Source |
|---|---|---|
| Equity (eq) | Includes transactions involving shares and other securities of a participating nature if they are not effected for the purpose of acquiring a lasting economic interest in the management of the enterprise concerned. Investments for the purpose of acquiring a lasting economic interest are addressed under foreign direct investments. | Klein (2012) |
| Bonds (bo) | Refers to bonds and other securities with an original maturity of more than one. The term "other securities" includes notes and debentures. | Klein (2012) |
| Money market (mm) | Refers to securities with an original maturity of one year or less and includes short-term instruments, such as certificates of deposit and bills of exchange. The category also includes treasury bills and other short-term government paper, bankers' acceptances, commercial papers, interbank deposits, and repurchase agreements. | Klein (2012) |
| Collective investment (ci) | Includes share certificates and registry entries or other evidence of investor interest in an institution for collective investment, such as mutual funds, and unit and investment trusts. | Klein (2012) |
| Derivatives (de) | Includes operations in rights, warrants, financial options and futures, secondary market operations in other financial claims, swaps of bonds and other debt securities, and foreign exchange without any other underlying transaction. | Fernandez et al. (2015) |
| Financial credits (fc) | Includes credits other than commercial credits granted by all residents, including banks, to nonresidents, or vice versa. | Klein (2012) |
| Direct investment (di) | Refers to investments for the purpose of establishing lasting economic relations both abroad by residents and domestically by nonresidents. These investments are essentially for the purpose of producing goods and services , and, in particular investments that allow investor participation in the management of the enterprise. The category includes the creation or extension of a wholly owned enterprise, subsidiary, or branch and the acquisition of full or partial ownership of a new or existing enterprise that results in effective influence over the operations of the enterprise. | Klein (2012) |
| Commercial credits (cc) | For operations directly linked with international trade transactions or with the rendering of international services. | Fernandez et al. (2015) |
| Guaranties and securities (gs) | provided by residents to nonresidents, and vice versa, which includes securities pledged for payment or performance of a contracts such as warrants, performance bonds, and standby letters of credits and financial backup facilities that are credit facilities used as a guarantee for independent financial operations. | Fernandez et al. (2015) |
| Real estate transactions (re) | Representing the acquisition of real estate not associated with direct investment, including, for example, investments of a purely financial nature in real estate or the acquisition of real estate for personal use. | Fernandez et al. (2015) |