Essays in Macroeconomics and Financial Markets

Francisco Queirós

TESI DOCTORAL UPF / ANY 2018

DIRECTORS DE LA TESI
Fernando Broner i Jaume Ventura

Departament d'Economia i Empresa

Universitat
Pompeu Fabra
Barcelona

Aos meus pais, aos meus irmãos e aos meus avós

Acknowledgements

The start of this thesis dates back to a train trip between Barcelona and Figueres. It was a Saturday morning and Tomas and I were starting a take-home exam for Jaume's course on asset bubbles. We were asked to extend the model that later became part of the "Managing Credit Bubbles" paper. I remember that I had already been fascinated by Jaume's theory of how bubbles could be expansionary. But after having been through the math of the model, I felt I could try to do some work on the topic. And after many trials and errors, this is how the first chapter of this thesis appeared.

This small prelude serves to thank Jaume. I have been extremely privileged for having him as one of my advisors - he certainly changed my way of thinking and, apart from being one of the most brilliant persons I have (and will ever) met, he has always been extremely kind and supportive. I also want to thank Fernando. He has always given me good advice and support and his sharp comments helped me improve my research significantly. I have also learnt a lot from him!

There are many other people who I wish to thank. Among all UPF professors I have met over the course of my PhD, I want to thank Andrea Caggese, Luca Fornaro, Jordi Galí, Julian di Giovanni, Alberto Martín, Andrea Polo and especially Manuel García-Santana. They were all of great help at different stages of my PhD. I also thank Enrique Moral-Benito for giving me access to the dataset of Spanish firms. A special mention is also owed to Marta and Laura, for their extraordinary efficiency and wittiness. Our department should build you a statue! Finally, I am grateful to Natércia Fortuna for encouraging me to do a PhD.

I also have to dedicate a few words to the friends I made over the last seven years. They were my second family and are of course part of my best memories from Barcelona. Un aplauso para el increíble asador Tomás Williams y para Carla. Muchas gracias a las chicas de Aragó 347, Ana, Cristina y María, por su hospitalidad. Grazie anche a Lorenzo e Marco, grandi maestri della cucina italiana. My thanks go also to Sir Darren Tang, to Niklas, Ricardo, Thomas, Miguel, Tom, Jagdish, Marta, Donghai and Inês. Many thanks also to my friends in Porto and especially to Bárbara for organizing a dinner every time I went home. And thanks to Alzira for cooking some of my favorite dishes.

Para terminar, meia dúzia de palavras na velha língua de Camões, dadas as saudades que tenho de escrever em português. Das muitas memórias que guardo destes sete anos em Barcelona, há uma que não posso deixar de recordar. Perdoem-me esta referência pouco poética e nada erudita, mas gostaria de evocar o dia 10 de Julho de 2016. Celebrar a vitória de Portugal na Praça da Catalunha é algo que nunca esquecerei. Ao Sr. Eng. Fernando Santos e ao nosso muito estimado capitão a minha humilde vénia de gratidão.

Finalmente, falando do que realmente importa, agradeço sobretudo à minha família - aos meus pais, aos meus irmãos e aos meus avós. Sempre me fizeram sentir perto e graças a eles aguentei momentos menos bons. Gostava de ter algo de que francamente me orgulhasse para lhes dedicar. Talvez um dia.

Abstract

This thesis is composed of three independent articles. The first two chapters are on the topic of asset bubbles. In the first chapter, I study the interactions between rational asset bubbles and product market competition. I build a theoretical model where I show that asset bubbles, by providing a production or entry subsidy, may have a pro-competitive effect and force firms to expand and cut profit margins. I use the model to interpret the evidence of two famous bubble episodes: the British *railway mania* of the 1840s and the *dotcom bubble* of the 1990s. In the second chapter, I provide a comprehensive characterization of non-fundamental stock price fluctuations at the industry level. Among other things, I show that overvaluation shocks tend to be more important in industries with higher profit margins or higher R&D intensity. I also document that, in periods of high overvaluation, stock market entrants tend to be less productive. In the third and last chapter I characterize the evolution of business dynamism in Spain between 1995 and 2007. Consistent with the evidence for other developed countries, I document a significant decline in the Spanish firm entry and exit rates over this period. I also show that, when compared to incumbents of the same industry, young firms have become relatively more productive. I build a model featuring firm dynamics and financial frictions to show how a decline in interest rates can explain these trends.

Resumen

Esta tesis se compone de tres artículos independientes. Los primeros dos capítulos están centrados en el tema de la sobrevaluación de activos. En el primer capítulo, construyo un modelo teórico para examinar los efectos de las burbujas financieras en el nivel de competencia entre las empresas. El principal resultado es que la aparición de burbujas financieras subsidia la actividad económica y la creación de empresas y, a través de estos canales, promueve la competencia. Dos episodios históricos - la *fiebre del ferrocarril* de los años 1840 en Inglaterra y la burbuja *dotcom* de los años 1990 - son interpretados a luz del modelo. En el segundo capítulo, estudio las fluctuaciones no fundamentales de los precios de acciones a nivel industrial. Entre otras cosas, muestro que las industrias caracterizadas por altos márgenes comerciales o elevados niveles de I+D son más propensas a choques de sobrevaluación. También documento que, en periodos de elevada sobrevaluación, las empresas que entran en el mercado de capitales tienden a ser menos eficientes. En el tercer y ultimo capitulo, caracterizo la evolución de la dinámica empresarial en España entre 1995 y 2007. Tal como ha sido documentado en otros países desarrollados, verifico una significante caída de las tasas de entrada y salida de empresas. También enseño que, cuando se comparan con empresas ya establecidas, las nuevas empresas tienden a ser más productivas. Construyo un modelo teórico con mercados financieros imperfectos para mostrar cómo estos hechos puede ser explicados por la caída de los tipos de interés que se observó en España en el mismo periodo.

Preface

This doctoral thesis brings together the results of three different research papers. They all emphasize that the workings of financial markets has important implications for macroeconomic outcomes.

The first two chapters are dedicated to the theory of rational bubbles. There is a widespread perception that stock prices often experience fluctuations that cannot be accounted for by fundamentals. Examples of such fluctuations include the rise and fall of technology stock prices in the late 1990s or of construction and real estate companies in the years prior to 2006. In light of some of these events, a recent class of macroeconomic models has been developed to explain how rational asset bubbles can sustain economic expansions.[1] Their emphasis has been mostly on financial market imperfections and, in particular, how asset bubbles can mitigate the existence of agency problems in credit markets.

In spite of the relevance of credit market imperfections in recent macroeconomic theory, these models are however silent about the impact of asset bubbles along other dimensions, such as the degree of competition in product markets. However, being phenomena that are typically concentrated in a small group of industries, stock market bubbles are often accompanied by significant changes in the market structure.

In the first chapter of this thesis, I construct a model to study the interactions between rational asset bubbles and product market competition. I first show that imperfect competition relaxes the conditions for the existence of rational bubbles. When they have market power, firms restrict output and investment to enjoy supernormal profits. This depresses the interest rate, making rational bubbles possible even when capital accumulation is dynamically efficient. Second, I show that by providing a production or entry subsidy, asset bubbles may have a pro-competitive effect and force firms to expand and cut profit margins. However, once they get too large they can lead to overinvestment and sustain corporate losses. I then use the model to interpret two famous stock market boom episodes - the British *railway mania* of the 1840s and the *dotcom* bubble of the late 1990s. While being

---

[1] See for instance Fahri and Tirole (2011), Kocherlakota (2009) and Martin and Ventura (2011, 2012, 2016).

more than 150 years apart, these two episodes have some common features. For instance, the upturn of stock prices preceded in both cases a period of intense competition, during which firms were forced cut profit margins. Furthermore, in both cases it is possible to find examples of companies investing beyond reasonable levels and experiencing substantial income losses.

In spite of a growing theoretical interest on the consequences of asset bubbles, we do not completely understand some aspects concerning non-fundamental fluctuations in stock prices. In particular, we do not have a clear sense of their magnitude, of how they relate to industry characteristics or whether they affect some real variables, such as productivity growth. In the second chapter of my thesis, I aim at answering some of these questions. To this end, I construct a measure of the overvaluation component of different industries. Among other things, I show that stock market overvaluation appears to be more volatile in industries with higher profit margins or higher R&D intensity. I also show that non-fundamental changes in stock prices seem to have an impact on firm-level outcomes. In particular, in periods of high overvaluation, stock market entrants tend to be less productive.

The study of the macroeconomic consequences of market power (one of the subjects of the first chapter) has made me enter in the debate concerning the evolution of competition in the US economy. There are some signs suggesting that competition has been declining in the US over the last four decades: increasing industry concentration, rising price-cost markups and lower rates of firm entry and exit have all been documented.[2]

Motivated by some of these facts, the third chapter of this thesis (coauthored with Enrique Moral-Benito) looks at trends in business dynamism in Spain. We have taken advantage of a longitudinal panel from the Bank of Spain containing balance sheet data for virtually all Spanish firms.

Consistent with the evidence for the US, we document a significant decline in the Spanish firm entry and exit rates over this period. We also show that, when compared to incumbents of the same industry, young firms have become relatively more productive. We argue that these facts may be associated with the decline in real interest rates experienced by Spain after the adoption of the euro.

---

[2] See Autor et al. (2017), Eeckhout and De Loecker (2017) and Haltiwanger (2015).

Contents

2 THE REAL SIDE OF STOCK MARKET EXUBERANCE 65

Chapter 1

ASSET BUBBLES AND PRODUCT MARKET COMPETITION

1.1 Introduction

> *"With valuations based on multiples of revenue, there's ample incentive to race for growth, even at the cost of low or even negative gross margins."*

> "Dotcom history is not yet repeating itself, but it is starting to rhyme*",*
> *Financial Times, March 12, 2015*

Stock markets often experience fluctuations that seem too large to be entirely driven by fundamentals. Major historical events include the Mississippi and the South Sea bubbles of 1720 or the British *railway mania* of the 1840s.A more recent example is that of the US stock market in the late 1990s, during the so called *dotcom* bubble: between October 1995 and March 2000, the Nasdaq Composite index increased by almost sixfold to then collapse by 77% in the following two years.[1] One common aspect among some of these stock market boom/bust

---

[1] Although there is no consensus among economists, a great deal of evidence suggests that technology stocks became overvalued in the late 1990s. For instance, Ofek and Richardson [2002] made simple calculations and showed that the stock market value reached by the entire internet sector at the peak of the *dotcom* bubble could only be accounted for, on the basis of the discounted

episodes is that they are associated with a particular market or good: for instance, the *railway mania* affected essentially the British railway industry and the *dotcom* bubble was an episode concentrated on a group of internet and high-tech industries. More recently, some policy-makers questioned the economic rationale behind the staggering increase in stock prices in the biotechnological and social media sectors: on 07/16/2014, Fed's chair Janet Yellen argued that "*Valuation metrics in some sectors do appear substantially stretched - particularly those for smaller firms in the social media and biotechnology industries*".

Being phenomena typically associated with a set of particular goods or industries, stock market overvaluation episodes are often accompanied by significant changes in the market structure. The *dotcom* bubble of the late 1990s constitutes perhaps a good example in this regard. In an environment characterized by a widespread excitement about the internet and soaring prices of technology stocks, many internet firms went public.[2] Furthermore, in an attempt to maximize their market values, these firms often sought for rapid growth and engaged in aggressive commercial practices, such as advertisement overspending, excess capacity or extremely low penetration prices. For instance, some online delivery companies appearing around this period (such as *Kozmo.com* or *UrbanFetch*) provided their services completely for free. Some firms would even make money payments to attract consumers: the advertising company *AllAdvantage.com* paid internet users to display advertisements on their screens. Most of these companies incurred in extensive income losses and could not survive the stock market crash in 2000 (see section 1.6).

---

value of future earnings, if estimated growth rates were unreasonably high (far above the rates historically observed for the fastest growing individual *firms* in the whole economy) and/or discount rates were absurdly low. Lamont and Thaler [2003] also documented clear examples of overpricing in a number of equity carve-outs. They studied in depth the case of 3Com (a profitable provider of network systems), which sold 5% of its subsidiary Palm (a computer producer) through an IPO in 2000. As it was documented, the price reached by the shares of Palm was so high that, if one were to subtract the implied value of the remaining 95% of Palm from 3Com, one would find that the non-Palm part of 3Com had a negative value.

[2] Goldfarb and Kirsch [2008] report that between 1994 and 2001 "approximately 50,000 companies solicited venture capital to exploit the commercialization of the internet"; among these, around 500 companies had an initial public offering.

But even if lacking market expertise or following unsustainable business models, these firms often posed a serious threat to incumbent companies and in some cases forced them to expand and enter in the online market. For instance, the appearance of many online toy retailers such as eToys, Toysmart, Toytime or Red Rocket (all of which went bankrupt after the stock market crash) forced Toys“R”Us to enter in the internet market by means of a partnership with Amazon. Some other companies, on the other hand, decided to expand even before a new competitor appeared. A well-known example in this category involves the “Destroy Your Business” program launched by GE’s CEO Jack Welch in 1999. Welch asked managers from different divisions of GE to go through a collective exercise and think of different ways in which a new *dotcom* company could destroy their leadership in specific markets. The main idea consisted in identifying new production processes or business opportunities before other companies did. As part of the “Destroy Your Business” initiative, many divisions of GE (such as GE Plastics, GE Medical Systems or GE Appliances) adopted cost-cutting programs and started providing new services through the internet. A more detailed description of these and other examples is done in section 1.6.

But what role did the stock market play in fostering competition in product markets? Was it indeed behind the aggressive commercial strategies pursued by the new internet firms? To answer these questions, it is important to notice that valuation models are often based on multiples of revenues or market shares and not on profits (Liu, Nissin and Thomas [2002] and Kim and Ritter [1999]). This is especially true in the case of young firms: they typically start with low or even negative profit margins, which makes it difficult to project *future* cash flows from *current* earnings. For instance, Hong and Stein [2003] provide detailed evidence that equity analysts offering valuations for Amazon in the 1997-1999 period tended to emphasize its growth path (in terms of sales) and highly disregarded operating margins. This type of valuation methods has obvious consequences on firms’ behavior, as it can induce managers to focus on revenue targets at the expense of profits (Aghion and Stein [2008]).[3] It can therefore have a positive and

---

[3] There is also ample evidence that this technique induced firms to choose aggressive revenue recognition practices during the *dotcom* years. These included the reporting of barter transactions and grossed-up (as opposed to net) revenue. Barter transactions were frequent among internet

pro-competitive effect, but can also force firms to expand excessively and incur in income losses. As noted in the context of the recent Silicon Valley boom: "***With valuations based on multiples of revenue, there's ample incentive to race for growth, even at the cost of low or even negative gross margins****. The many taxi apps and instant delivery services competing for attention, for example, are facing huge pressure to cut prices in the hope of outlasting the competition*".[4]

Income losses were indeed prevalent during the *dotcom* boom. As Ofek and Richardson [2002] document, public Internet firms had aggregate revenues of $ 27.429 billion in 1999, but negative EBITDA and net income of (minus) $5.750 billion and (minus) $9.888 billion respectively (the aggregate stock market capitalization for the sector was $ 942.967 billion). Negative earnings could also be detected at the aggregate-industry level. Figure 1.1 shows economy-aggregate earnings and revenues for three industries at the center of the *dotcom* boom - 'Publishing Industries (Software)', 'Information and Data Processing Services' and 'Computer Systems Design and Related Services'. It also shows the price-sales ratio for the universe of publicly listed firms in those industries. As one can see, two of these industries exhibited negative aggregate profits at the peak of the boom in 2000. Furthermore, there seems to be a negative relationship between aggregate profits and stock prices in the three industries: aggregate profits decline in the boom period 1998-2000, but start increasing after the stock market crash.[5]

The recurrence and magnitude of recent stock market boom/bust episodes (such as the *dotcom* bubble of the late 1990s) has somehow prompted a revived interest in the old theory of rational bubbles, which dates back to the seminal contributions of Samuelson [1958] and Tirole [1985]. In particular, recent macroeconomic models have been developed to explain how asset bubbles may mitigate the existence of financial frictions and promote economic growth.[6] In spite of

---

firms as they used to exchange advertising space in their websites, leaving managers with the faculty to assess the fair value of their revenues and expenses. See Bowen, Davis and Rajgopal [2002].

[4] "Dotcom history is not yet repeating itself but it is starting to rhyme" (03/12/2015), Financial Times

[5] Due to changes in industry classification, data on aggregate profits and revenues is not available for earlier years.

[6] As it is well known, the presence of agency problems may limit firms' capacity to borrow

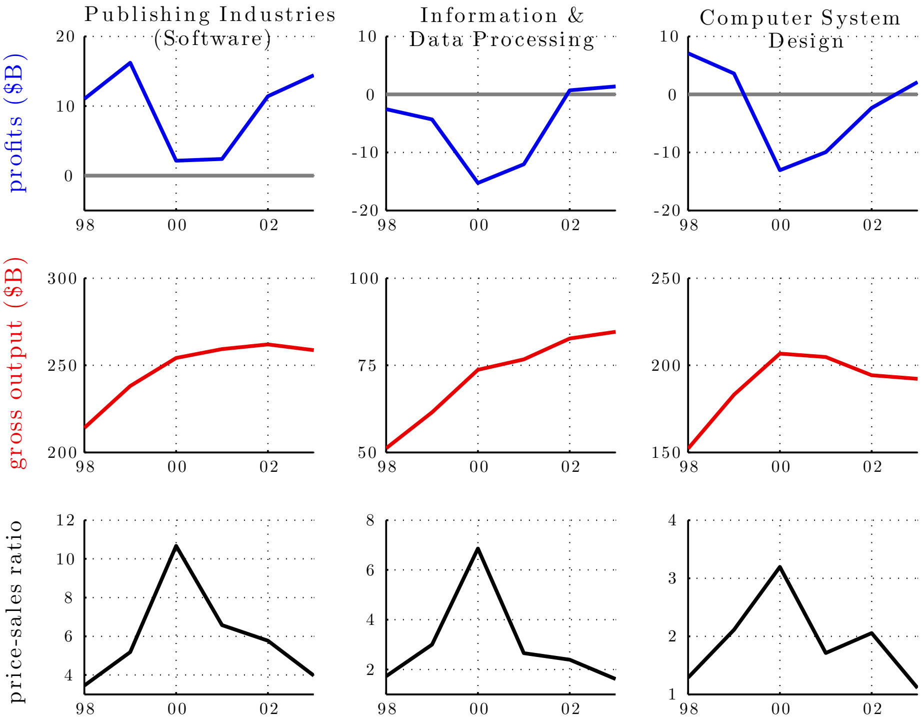


Figure 1.1: Revenues and Profits at the Industry Level

This figure shows economy-aggregate profits and revenues for three different industries ('Publishing Industries (Software)', 'Information and Data Processing Services' and 'Computer Systems Design and Related Services') and the price-sales for the universe of publicly listed firms in those industries. 'Profits' refers to 'Corporate Profits Before Tax by Industry' (from BEA - NIPA Table 6.17D) and 'Revenues' refers to 'Gross Output by Industry' (from BEA). 'Price-Sales' is the ratio of total stock market capitalization (stock price times common shares outstanding, from CRSP) to total sales (COMPUSTAT item #12), constructed at the beginning of the corresponding year.

the undisputed relevance of credit market imperfections, these models are however silent about the effects of asset bubbles on the market structure and on the degree of competition in product markets. Furthermore, they fail to explain how overvaluation may sustain overinvestment and generate income losses. As I shall argue, these have been important aspects of the *dotcom* bubble of the late 1990s, but could be also found in other historical episodes, such as the British *railway mania* of the 1840s (see section 1.6).

In this paper, I aim at studying the interaction between asset bubbles and product market competition. To this end, I develop a standard multi-industry model with imperfect competition. In each industry there is a productive firm (the *leader*) which faces competition from a fringe of relatively inefficient competitors (the *followers*). Absent the formation of bubbles, the leader's optimal decision is to set a limit price that prevents the entry of the followers (therefore enjoying supernormal profits).

I first show that imperfect competition depresses the interest in general equilibrium, hence relaxing the conditions for the existence of rational bubbles. Having market power, firms limit output and investment relative to the social optimum. As a result, both the demand for credit and the interest rate may be sufficiently depressed so that rational asset bubbles become possible even when capital accumulation is dynamically efficient.[7]

This is a novel insight. In standard models that incorporate rational bubbles, low interest rates are achieved through two main channels: dynamic inefficiency and financial frictions. In the first one, low interest rates are the result of excessive savings and/or unproductive investment technologies (as for instance in Samuel-

---

and hence to undertake efficient investment plans. It is within this context that asset bubbles may be useful. Either by being a liquidity instrument (Fahri and Tirole [2011], Hirano and Yanagawa [2017], Kocherlakota [2009], Miao and Wang [2012]) or a source of collateral (Martin and Ventura [2011, 2012, 2016] and Tang [2017]), bubbles may help constrained firms increase investment and therefore be associated with economic expansions.

[7] From a theoretical standpoint, it is well known that rational asset bubbles can only emerge in economies where the interest rate is depressed, i.e. lower than the growth rate. The argument is straightforward. On the one hand, for rational bubbles to exist they must offer a return that is not lower than the interest rate. On the other hand, bubbles cannot grow faster than the economy (otherwise they can be ruled out with simple backward induction arguments).

son [1958] and Tirole [1985]). In the second, they are the consequence of financial market imperfections (such as limited pledgeability) that constrain firms' borrowing capacity and hence their demand for credit (as in Farhi and Tirole [2011] and Martin and Ventura [2011, 2012, 2016]).[8] In this paper, low interest rates are the result of a low demand for credit, as it happens in the presence of credit market imperfections. However, here the mechanism is quite different: at a given interest rate, firms do not borrow more not because they *cannot* do so, but rather because they *do not want* to do so. As we shall see, this difference will have important implications.

I also show that asset bubbles may have a pro-competitive effect and be expansionary. For instance, if the followers can create bubbly firms and overvaluation is proportional to revenues or market shares, they may be willing to produce even when incurring in an operational loss. This may force the leader to set a lower limit price, in order to keep his monopoly position. Therefore, even if attached to unproductive firms, bubbles can nevertheless induce an efficient reaction on the part of incumbents. In this paper I emphasize this new channel: by providing a return that mimics an entry or production subsidy, asset bubbles may reduce entry barriers and incumbents' market power. For this mechanism to work, it is however crucial that the followers can benefit from the formation of bubbles or pyramid schemes. If only the leaders can create overvalued firms, they will typically not expand: they just need to set a limit price to prevent the entry of the followers. The assumptions we make about the distribution of bubbles across firms will therefore be a crucial aspect of the model.[9]

I also show that asset bubbles can have economic consequences even if they

---

[8] When there are externalities to capital accumulation (as it happens in models of learning-by-doing) the fact that the interest rate is below the growth rate is not an indication of dynamic inefficiency since there may be a wedge between the private and the social return to capital. Bubbles will be possible when the private return to capital is below the growth rate. However, as long as the social return to capital is greater than this last, the economy will be dynamically efficient. This is what happens in the models of Grossman and Yanagawa [1993], King and Ferguson [1993] and Olivier [2000].

[9] I also show that overvaluation can foster competition and lead to an output expansion even if not linked to any activity variable. This may happen in two main situations: in the presence of financial frictions (section 1.4) or when there are fixed production costs (appendix 1.8).

do not materialize: the very belief that the followers can create overvalued firms (if they produce) will be sufficient to force the leader to expand. This is a situation of a *latent* bubble: bubbles or pyramid schemes can emerge if new firms enter in the market; however, it may be in the best interest of incumbents to blockade the entry of new competitors, as in the example of GE described above. The model will therefore provide a theory for bubble-driven business cycles even when firm values do not deviate from fundamentals.

Even if leading to output expansions, bubbles may nevertheless generate several inefficiencies. By being proportional to revenues or market shares, overvaluation may force firms to expand output beyond the social optimum (therefore incurring in income losses) in order to maximize their market value. The model therefore offers a simple rationale for the prevalence of income losses among technological and internet firms at the peak of the *dotcom* bubble in the years of 1999 and 2000.

Some extensions are considered. First, in line with the recent literature on rational asset bubbles, I introduce financial frictions by means of a limited pledgeability problem. I show that financial frictions have a stronger impact on the least productive firms, thus reinforcing the leaders' market power (section 1.4). In such case, bubbles may provide the followers with additional collateral (even if not proportional to revenues or market shares) thereby forcing the leaders to expand. Second, I introduce endogenous product variety and put competition in a dynamic perspective. By reducing market power in old industries, asset bubbles can foster the development of new industries and growth. However, if they increase competition in new sectors bubbles may hinder economic growth (section 1.5).

I also show that the main results of this paper are robust to different formulations of product market frictions. In the benchmark model, imperfect competition stems from the fact that only one firm can make use of the best available technology. However, I show that the main results go through if all firms are equally productive but there are fixed production cost (which creates increasing returns to scale). In such case, it is still possible to construct rational bubble equilibria in economies that are dynamically efficient. Furthermore, by providing an entry subsidy asset bubbles also promote competition and force operating firms to expand (appendix 1.8).

The rest of the paper is organized as follows. Section 1.2 describes the benchmark economy with no bubbles. It shows that bubbly equilibria will be possible even when the economy is dynamically efficient. Section 1.3 looks at different bubbly equilibria and explores its implications in terms of the market structure, investment and output. Section 1.4 introduces financial frictions and compares the results to the ones of previous models. Section 1.5 introduces endogenous growth and looks at the consequences of asset bubbles in a dynamic perspective. Section 1.6 reviews some anecdotal evidence from two important stock market overvaluation episodes: the British *railway mania* of the 1840s and the *dotcom* bubble of the late 1990s. These episodes are reinterpreted through the lens of the theory developed in this paper. Section 3.4 concludes. Before proceeding, I offer a brief review of the related literature.

1.1.1 Related literature

This paper is mostly related to the literature that forms the theory of rational bubbles. Different models have emphasized different aspects of asset bubbles. In very broad terms, we can divide the literature in two categories. On the one hand, there are models that view bubbles as assets whose main role is being a store of value. This is the central tenet of the seminal contribution of Samuelson [1958] who argues that bubbles may complete intergenerational markets and provide for an efficient intertemporal allocation of resources. Tirole [1985] makes the same point in the context of the neoclassical growth model, emphasizing a *crowding-out* effect: bubbles drive resources away from investment. However, in the model of Tirole this effect happens to be welfare-improving as it eliminates inefficient capital accumulation.[10] Being a store of value, bubbles can also be a liquidity instrument that may help firms overcome financial frictions as in Caballero and Krishnamurthy [2006], Farhi and Tirole [2012], Hirano and Yanagawa [2017], Kocherlakota [2009] or Miao and Wang [2012]. Finally, Ventura [2012]

---

[10] Some authors have later pointed out that in the presence of externalities to capital accumulation, such crowding-out effect could be growth-impairing and welfare-reducing. This is the main message of the endogenous growth models of Grossman and Yanagawa [1993] and King and Ferguson [1993].

shows that bubbles can increase the return on savings in low productivity countries, thereby eliminating cross-country differences in rates of return and acting as a substitute for capital flows.

A different strand of the literature, on the other hand, has put emphasis on the formation of new bubbles: the formation of a new pyramid scheme always provides some kind of subsidy or return that can have economic consequences. Within this category, we find the model of Olivier [2000] who shows that if attached to R&D firms, bubbles can stimulate the invention of new goods and foster economic growth. More recently, Martin and Ventura [2011, 2012, 2016] argue that the creation of new bubbles may be a source of collateral that allows credit-constrained firms to borrow and invest more. I will provide a theory of how asset bubbles can be expansionary and I will focus on bubble formation. My paper will be closest in spirit to the models of Martin and Ventura [2011, 2012, 2016], though there will be important differences and conclusions. Here, the focus will be on frictions in product markets, not in financial markets. I will also consider the limited pledgeability problem and discuss how it may exacerbate imperfect competition in final goods markets.

In this paper I will allow firm overvaluation to depend on revenues or market shares (consistent with systematic and anecdotal evidence about valuation models). I should however stress that the possibility that overvaluation is a function of fundamentals has already been admitted by the rational bubbles literature. For instance, Froot and Obstfeld [1991] constructed a simple asset pricing model with rational bubbles that are a function of dividends. However, this is perhaps the first paper to explicitly study the economic implications of such hypothesis.

By establishing a connection between product market competition and the interest rate, the model can also shed light on recent macroeconomic trends. There are signs suggesting that market power has been increasing in the US since the 1980s. Using a sample of publicly listed firms, De Loecker and Eeckhout [2017] document a substantial increase on average markups from 1980 to now. Such increase on average markups has been accompanied by a decline in business dynamism, particularly evident in a secular decline in the startup rate and a greater concentration of activity and employment in larger and older firms (Decker et al. [2014]). All these trends have coincided with a persistent decline in real interest rates, which have even become negative in recent years. Even though there may be multiple forces contributing to the decline of interest rates, the model presented in this paper suggests that it can be linked to the increase in market power.

This paper is also related to a vast literature studying the cyclical properties of markups which includes contributions by Rotemberg and Woodford [1992] and Chevalier and Scharfstein [1996]. Finally, this paper speaks to the literature describing firm and investor behavior during the British railway *mania* of the 1840s (Campbell and Turner [2010, 2012, 2015], Odlyzko [2010]) and during *dotcom* bubble of the late 1990s (such as Brunnemeier and Nagel [2004], Griffin et al. [2011] and Campello and Graham [2013]). It is important to mention that some authors have proposed fundamental-based explanations for the *dotcom* bubble of the late 1990s. For instance, Pastor and Veronesi [2009] argue that the level attained by the Nasdaq index at its peak in the year 2000 could be explained on the basis of high uncertainty about the newly formed internet sector. Under such view, investors were initially uncertain about the long-run profitability of the internet sector and revised their expectations downwards as profits declined in 2000/2001. The paper presents a quite different view: the low profitability levels reached by internet companies in 2000/2001, rather than the realization of a stochastic process, were an endogenous reaction to high stock prices. This view seems to receive support from anecdotal evidence reviewed in section 1.6.

1.2 The Benchmark Economy with no Bubbles

The model is built upon the popular overlapping generations model by Diamond [1965]. There is an economy populated by two overlapping generations. Members of the first generation will be referred to as the young, and members of the second as the old. Within each generation, there will be two types agents: the workers and the entrepreneurs. Each generation-type has measure one. All agents are born with no wealth and maximize old-age consumption:

$$U_{i,t} = C_{i,t+1}$$

where $U_{i,t}$ is the welfare at time t of a young agent i and $C_{i,t+1}$ is his consumption when old. Throughout, I assume there is no uncertainty.

Workers supply inelastically one unit of labor when young and get a wage w_t. The wage will naturally be saved. Workers will have to choose between two savings schemes. On the one hand, they have access to a storage technology with gross return $r < 1$. On the other hand, they can buy financial securities promising a state-contingent gross return R_{t+1}. Storage must be seen as an inefficient investment opportunity that may nevertheless be used in equilibrium. The supply of funds in the credit market will therefore be given by

$$F_t^S = \begin{cases} = w_t & \text{if} \quad R_{t+1} > r \\ \in [0, w_t] & \text{if} \quad R_{t+1} = r \end{cases} \tag{1.1}$$

When they retire, workers will run a firm in the final goods sector, which operates under perfect competition. They will hire L_{t+1} units of labor (supplied by young workers) and buy capital goods K_{t+1} to produce Y_{t+1} units of the final good according to a Cobb-Douglas technology

$$Y_{t+1} = L_{t+1}^{1-\alpha} \cdot K_{t+1}^{\alpha} \tag{1.2}$$

Capital fully depreciates in production. It is be a CES composite of different intermediate inputs, which have measure one:

$$K_{t+1} = \left(\int_0^1 x_{i,t+1}^{\rho} \, di \right)^{\frac{1}{\rho}} \tag{1.3}$$

where $x_{i,t+1}$ is the quantity of intermediate $i \in [0,1]$, $0 < \rho < 1$ and $\sigma \equiv \frac{1}{1-\rho}$ is the elasticity of substitution among inputs. The parameter ρ can be seen as a measure of substitution among inputs. When ρ is low, differentiation is high and firms can possibly have high market power.[11] The final good will be used as the *numeraire*.

Since young workers supply one unit of labor inelastically and they have measure one, the labor market clears at $L_{t+1} = 1$. Factor markets are competitive and factors are paid their marginal product

$$w_{t+1} = (1-\alpha) \cdot Y_{t+1} \tag{1.4}$$

---

[11] As $\rho \to 1$, capital becomes linear in intermediates; in this case, they will be perfect substitutes. As $\rho \to 0$, capital becomes a Cobb-Douglas aggregate of intermediates; in such case, production requires a strictly positive amount of each variety and the degree of differentiation is very high.

$$q_{t+1} = \alpha \cdot K_{t+1}^{\alpha-1} \tag{1.5}$$

$$p_{i,t+1} = q_{t+1} \cdot \left(\frac{K_{t+1}}{x_{i,t+1}} \right)^{1-\rho} \tag{1.6}$$

where w_{t+1} is the wage rate, q_{t+1} is the rental rate and $p_{i,t+1}$ is the price of intermediate input $i \in [0, 1]$.

Intermediate inputs will be produced by the young entrepreneurs, who will be indexed by $j \in [0, 1]$. The production of intermediates uses the final good as its only input. To motivate the existence of a credit market, I assume it needs to be invested one period in advance. Moreover, I will assume constant returns to scale so that entrepreneur $j \in [0, 1]$ produces intermediate $i \in [0, 1]$ according to

$$x_{i,t+1}^{j} = \pi_{i,t}^{j} \cdot m_{i,t}^{j} \tag{1.7}$$

where $x_{i,t+1}^{j}$ is the output of the intermediate good, $m_{i,t}^{j}$ the quantity of the final good used and $\pi_{i,t+1}^{j}$ is the productivity of entrepreneur $j \in [0, 1]$ in the production of intermediate $i \in [0, 1]$. The assumptions about the distribution of productivity types will be a crucial element of the model. I will assume that

$$\pi_{i,t}^{j} = \begin{cases} 1 & \text{if} \quad j = i \\ \pi < 1 & \text{if} \quad j \neq i \end{cases} \tag{1.8}$$

Therefore, each variety $i \in [0, 1]$ can be produced either with productivity $\pi_{i,t}^{j} = 1$ by entrepreneur $j = i$ or with productivity $\pi < 1$ by all the others. I will refer to entrepreneur $j = i$ as the *leader* of industry i and to all other entrepreneurs $j \neq i$ as the *followers*. Note that every entrepreneur is a leader in one industry and a follower in all the other markets. However, the important aspect of (1.8) is that for every input variety there is only one individual with access to the best technology. This is a crucial assumption, since it creates scope for imperfect competition and market power. Since they are born with no wealth, young entrepreneurs need to raise funds to invest. In order to do so, they sell financial securities in the credit market. Clearly, in equilibrium all financial securities must promise the same return R_{t+1}.

1.2.1 Industry Equilibrium

Before solving for the general equilibrium of the economy, let us look at each individual industry separately. If the leader were granted a monopoly, he would solve

$$\max_{x_{i,t+1}} \left[q_{t+1} \cdot \left(\frac{K_{t+1}}{x_{i,t+1}} \right)^{1-\rho} - R_{t+1} \right] \cdot x_{i,t+1}$$

where I used the fact that $p_{i,t+1} = q_{t+1} \cdot \left(\frac{K_{t+1}}{x_{i,t+1}} \right)^{1-\rho}$. The solution to this problem yields

$$x_{i,t+1} = \left(q_{t+1} \cdot \frac{\rho}{R_{t+1}} \right)^{\frac{1}{1-\rho}} K_{t+1}$$

and

$$p_{i,t+1} = \underbrace{\frac{1}{\rho}}_{\text{markup}} \cdot \underbrace{R_{t+1}}_{\text{marginal cost}}$$

This a well-known result: given an elasticity of substitution equal to $\frac{1}{1-\rho}$, the monopoly price consists of markup $\frac{1}{\rho}$ over the marginal cost. However, as long as $\pi > \rho$ we have $p_{i,t+1} > \frac{R_{t+1}}{\pi}$, implying that the followers would be willing to enter in the industry. This forces the leader to set a limit price equal to the followers' marginal cost $\frac{R_{t+1}}{\pi}$ and to produce a quantity greater than the monopoly level. In this case we observe[12]

$$x_{i,t+1} = \left(q_{t+1} \cdot \frac{\pi}{R_{t+1}} \right)^{\frac{1}{1-\rho}} K_{t+1} \tag{1.9}$$

$$p_{i,t+1} = \frac{R_{t+1}}{\pi} \tag{1.10}$$

To sum up, as long as $\pi > \rho$ the leader will charge a price-cost markup below his desired level to prevent the entry of the followers. This markup is equal to $\frac{1}{\pi}$, implying a profit share on revenues equal to $1 - \pi$.

Throughout this paper, I will focus on the case in which $\pi > \rho$ to ensure that the leader always faces competition from the followers. This happens either when the productivity gap is not very large (π is close to one) or when the desired markup is high (ρ is low). Equations (1.9) and (1.10) determine the equilibrium

---

[12] Combining equations (1.5) and (1.6), we have $p_{i,t+1} = \alpha \cdot K_{t+1}^{\alpha-\rho} \cdot x_{i,t+1}^{\rho-1}$.

quantity and price of industry $i \in [0,1]$ given the capital stock and the interest rate of the economy. We shall now see how these aggregate variables are determined.

1.2.2 General Equilibrium

To determine the aggregate capital stock, we can start by combining equations (1.3), (1.5) and (1.9) to find that

$$K_{t+1} = \left(\frac{\pi \cdot \alpha}{R_{t+1}}\right)^{\frac{1}{1-\alpha}} \tag{1.11}$$

This equation establishes a negative relationship between the capital stock and the interest rate. Since there are diminishing returns to capital, a higher capital stock implies a lower rental rate and a lower interest rate through (1.10). Let us now determine K_{t+1} and R_{t+1}. Equilibrium in the credit market requires that $K_{t+1} = F_t^S$, where F_t^S is the amount of credit supplied by young workers at time t. We can combine this condition with equations (1.1), (1.4) and (1.11) to find the law of motion of this economy

$$K_{t+1} = \min\left\{(1-\alpha) \cdot K_t^{\alpha}, \left(\frac{\pi \cdot \alpha}{r}\right)^{\frac{1}{1-\alpha}}\right\} \tag{1.12}$$

$$R_{t+1} = \pi \cdot \alpha \cdot K_{t+1}^{\alpha-1} \tag{1.13}$$

Equation (1.12) just says that when savings are low, the storage technology is not used. In this case all labor income can be invested with a high return (i.e. greater than the return on storage r). If savings are sufficiently high, then only a fraction will be converted into capital so that the rental rate does not fall short of r. Equation (1.13) determines the interest rate as a function of the capital stock; it also implies that (gross) interest payments represent a fraction $\pi \cdot \alpha$ of aggregate output. To understand this result, note that the labor and capital shares are equal to respectively a fraction $1-\alpha$ and α of output. Of this last share, a fraction $1-\pi$ represents profits in the intermediate inputs sector, and the remaining fraction π represents interest payment to creditors.

Note that despite the assumptions about the distribution of productivity types and the market structure, this economy behaves as a standard Solow model. It will converge to a steady-state characterized by

$$K^* = \min\left\{(1-\alpha)^{\frac{1}{1-\alpha}}, \left(\frac{\pi\cdot\alpha}{r}\right)^{\frac{1}{1-\alpha}}\right\} \tag{1.14}$$

$$R^* = \max\left\{\frac{\pi\cdot\alpha}{1-\alpha}, r\right\} \tag{1.15}$$

1.2.3 Dynamic Efficiency and the Steady-State Interest Rate

There are a few aspects that are worth discussing. The first one pertains to the effect of imperfect competition on the interest rate. As we can see from equation (1.13), the interest rate is lower than the social return to investment $\alpha \cdot K_{t+1}^{\alpha-1}$.

$$R_{t+1} = \pi\cdot\alpha\cdot K_{t+1}^{\alpha-1} < \alpha\cdot K_{t+1}^{\alpha-1}$$

This wedge is a direct consequence of imperfect competition in the market for intermediates. In each industry, the leader sets a price above his marginal cost of production and restricts investment. This lowers the demand for credit and depresses the interest rate in general equilibrium.

A second aspect has to do with the relationship between the interest rate and capital overaccumulation. In the standard OLG of Diamond [1965], there is overaccumulation of capital (i.e. the economy is dynamically inefficient) if and only if the interest rate is below the economy's growth rate. This results implies that rational asset bubbles are possible if and only if capital accumulation is dynamically inefficient.[13] However, such equivalence need not be true under the current framework given the presence of imperfect competition. To assess this hypothesis, let us ignore storage for a moment (assume that $r \to 0$), so that in equilibrium all savings are intermediated. In this case, the economy converges to a steady-state characterized by

$$K^* = (1-\alpha)^{\frac{1}{1-\alpha}} \quad , \quad Y^* = (1-\alpha)^{\frac{\alpha}{1-\alpha}}$$

In such steady-state, the interest rate will be equal to

$$R^* = \frac{\pi\cdot\alpha}{1-\alpha}$$

---

[13] Recall that in equilibrium asset bubbles grow at the rate of interest. Therefore, they are only possible if the steady-state interest rate is below the long-run growth rate.

Therefore, the interest rate will be below the growth rate (and hence rational bubbles are possible) if and only if

$$1-\alpha > \pi \cdot \alpha \tag{1.16}$$

This condition says that the steady-state interest rate is lower than one if the savings rate $s = 1-\alpha$ is higher than the share of output that accrues to lenders $\pi \cdot \alpha$. Note that this last share depends positively π which, as we have seen, is inversely related to the degree of market power.

But under what conditions is capital accumulation dynamically efficient (i.e. the economy does not overaccumulate capital)? To answer this question, note that the steady-state capital accumulation is efficient if the marginal product of capital is above its marginal cost of production. Formally this happens if

$$\left.\frac{\partial Y(K)}{\partial K}\right|_{K=K^*} \geq 1$$

It is easy to verify that such condition is verified as long as

$$1-\alpha \leq \alpha \tag{1.17}$$

This is a well-known result. It says that the economy does not feature capital overaccumulation if the savings rate $s = 1-\alpha$ is not higher than the capital share in production α. A comparison between conditions (1.16) and (1.17) shows that if π is sufficiently low, the interest rate can be below one even when capital accumulation is dynamically efficient. This simple model therefore provides an environment where rational bubbles are possible even when the economy is dynamically efficient. Figure 1.2 summarizes these two conditions in the (α, π) space. Rational asset bubbles can emerge in both regions I and II. In these two regions we have $1-\alpha > \pi \cdot \alpha$ and the steady-state interest rate is lower than one. In region I, this happens because there is overaccumulation of capital, i.e. $1-\alpha > \alpha$. This steady-state is inefficient as the welfare of all generations could be increased if investment were lower. In region II, we have $1-\alpha < \alpha$ and hence there is no overaccumulation of capital. However, the interest rate is still depressed because the leaders have a large productivity advantage over the followers (π is low) and hence high market power. In this case, the demand for funds is depressed because each individual monopolist restricts investment to enjoy monopoly rents. Putting it differently, the leaders are only willing to absorb the existing level of savings if the cost of borrowing is sufficiently low.

The above discussion may appear somehow puzzling. I have argued that even if the economy is dynamically efficient, the interest rate can be low because imperfect competition depresses the demand for funds. Nevertheless, the two above conditions only impose a joint restriction on α (the capital share in the aggregate production function) and π (the relative efficiency of the leader). Indeed, they say nothing about the degree of product substitutability, captured by ρ. However, this parameter plays an important role: all the above equations were derived under the condition that $\pi > \rho$. This condition forces the leader to expand output beyond their optimal level in order to prevent the entry of the followers. If this condition was not satisfied, the presence of the followers would make no difference within this setup without bubbles: each leader would be a monopolist.[14] To sum up, for bubbles to be possible when there is no overinvestment, the productivity gap must be sufficiently high. Given the condition that $\pi > \rho$, this requires ρ (the degree of product substitutability) to be low.

All the above results were derived under the assumption that $r \to 0$ so that storage was never used in equilibrium. However, as it can be seen from (1.14), storage will be used if

$$r > \frac{\pi \cdot \alpha}{1 - \alpha}$$

Therefore, as long as

$$\frac{1}{2} < \alpha < \frac{r}{\pi + r} \tag{1.18}$$

we will observe underinvestment: storage is used even if the aggregate return to investment is above one. This happens in region II.1 of Figure 1.2. In such case, when bubbles appear they will crowd-out storage and will not be contractionary. I will assume that (1.18) holds, so that there is underinvestment in the bubbleless

---

[14] If $\pi \leq \rho$ and $r \to 0$ (storage is never used), the economy would converge to the same steady state as before: $K^* = (1-\alpha)^{\frac{1}{1-\alpha}}$. Therefore, the condition for investment to be efficient would still be the same, namely that $\alpha \geq \frac{1}{2}$. However, now we would observe $R^* = \rho \cdot q^* = \rho \frac{\alpha}{1-\alpha}$. Therefore, $R^* < 1 \Leftrightarrow \rho < \frac{1-\alpha}{\alpha}$. As we can see, the condition for the existence of bubbles now depends directly on the degree of market competition: ρ needs to be sufficiently low.

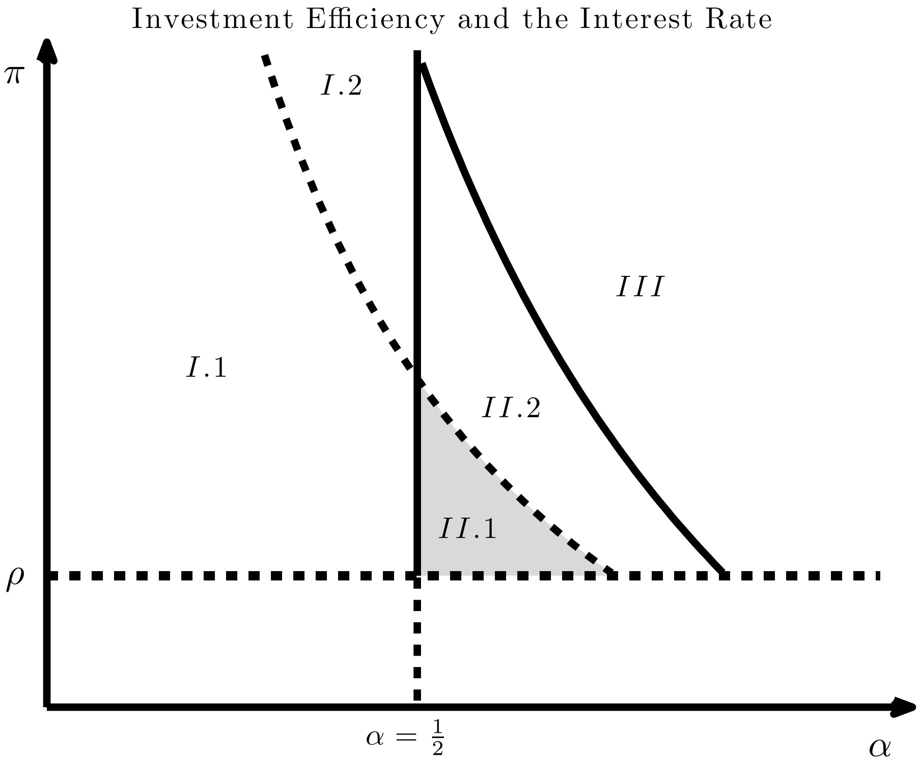


Figure 1.2: Investment Inefficiency and the Interest Rate in the Benchmark Economy

equilibrium. As we shall see in the next section, if fostering competition, bubbles can lead to an expansion in output. The results will however depend on the distribution of bubbles across firm types.

Region	Interest Rate	Efficiency of Investment	Storage
I.1	$R^* = r < 1$	Dynamic Inefficiency	Yes
I.2	$r < R^* < 1$	Dynamic Inefficiency	No
II.1	$R^* = r < 1$	Dynamic Efficiency	Yes
II.2	$r < R^* < 1$	Dynamic Efficiency	No
III	$R^* > 1$	Dynamic Efficiency	No

Table 1: Steady-State of the Benchmark Economy

1.3 The Bubbly Economy

Before proceeding it is perhaps useful to clarify the concept of bubble creation. Every young entrepreneur $j \in [0, 1]$ needs to raise funds in oder to invest. To do so, he must sell financial securities in the credit market, promising a gross return R_{t+1}. Let d^j_{t+1} be the dividends these securities pay at time $t + 1$. Their *fundamental* price at time t is defined as

$$f^j_t := \frac{d^j_{t+1}}{R_{t+1}} \tag{1.19}$$

Is this price we should observe? The answer is no, as there may be a bubble component attached to it. That is, the price may be equal to

$$v^j_t = \frac{d^j_{t+1}}{R_{t+1}} + \frac{b^j_{t+1}}{R_{t+1}} \tag{1.20}$$

where $b^j_{t+1} \geq 0$ is the bubble component, as of time $t+1$, attached to the securities issued by entrepreneur j at time t. Throughout this paper, I will refer to b^j_{t+1} as the new bubbles created by entrepreneur j. As we will see, the way b^j_{t+1} is determined will be a crucial aspect of the model. For the time being, I must only stress that $b^j_{t+1} > 0$ can be consistent with a perfect information and rational expectations equilibrium. Even if the securities issued by entrepreneur j at time t pay a single dividend d^j_{t+1}, any saver at time $t + 1$ would be willing to pay $d^j_{t+1} + b^j_{t+1}$ if he can resell them by $R_{t+2} \cdot b^j_{t+1}$ in the subsequent period.

1.3.1 Industry Equilibrium

Let us focus on an arbitrary industry $i \in [0, 1]$ and consider three different processes for the creation of bubbles.

Constant Bubbles at the Firm Level

Assume that entrepreneur $j \in [0, 1]$ operating in industry $i \in [0, 1]$ can create a firm with a fixed bubble component $b^j_{i,t+1} > 0$. How would such bubble affect the industry equilibrium? As it should be clear, the equilibrium would be exactly the same as before. The leader has no incentive to expand his output beyond the one given by equation (1.9): this is the output level that maximizes his profits given the competition he faces from the followers. On the other hand, the followers do not invest their resources as long as the leader produces the quantity that guarantees $p_{i,t+1} = \frac{R_{t+1}}{\pi}$. Therefore, if every entrepreneur gets a constant bubble that is not linked to any variable he can control (for instance output), there will be absolutely no effect in the industry equilibrium. This would be not true in the presence of financial frictions (section 1.4) or when there are fixed production costs (appendix 1.8).

Constant Bubbles at the Industry Level

Assume that instead of being created by each individual entrepreneur, bubbles are created at the industry level. In particular, assume there is a bubble with size $b_{i,t+1} > 0$ being created in industry i at time $t+1$ and that each entrepreneur gets a fraction that is equal to his market share. To understand this bubble, think for instance of the British railway industry in 1845 or in some internet or high-tech industry in 1999. According to this process, investors' total demand for shares in this such industry exceeds its fundamental value by a fixed amount $b_{i,t+1}$. Furthermore, this industry-aggregate bubble is distributed across firms according to their market shares, so that bigger firms get a larger share in the bubble. This assumption is not unrealistic: as discussed above, the valuation of firms is often based on multiples of revenues or market shares. This bubble process could indeed provide a rationale for such valuation methods.

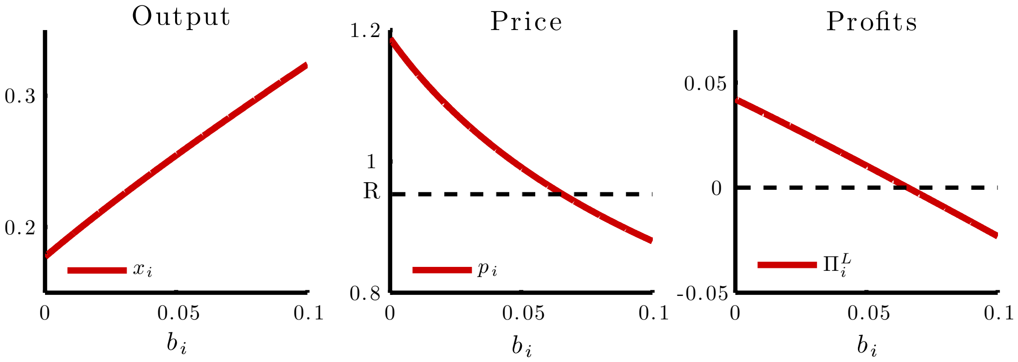
Under these conditions, will the leader still produce the quantity given by (1.9)? The answer is no. To see this, note that for any industry output level $x_{i,t+1}$ such that

$$\frac{R_{t+1}}{\pi} < p_{i,t+1} + \frac{1}{x_{i,t+1}} \cdot b_{i,t+1}$$

the followers can profitably enter! The reason that their marginal cost of production is still $\frac{R_{t+1}}{\pi}$, but they now get an additional return of $\left(\frac{1}{x_{i,t+1}}\right) b_{i,t+1}$ per each unit that they sell. Therefore, to prevent the entry of the followers, the leader must set a limit price lower than the followers' marginal cost so that the above condition holds with equality. In this case, output is implicitly defined by

$$\frac{R_{t+1}}{\pi} \cdot x_{i,t+1} = \alpha \cdot x_{i,t+1}^{\rho} \cdot K_{t+1}^{\alpha-\rho} + b_{i,t+1} \tag{1.21}$$

where equations (1.5) and (1.6) have been used. It can be easily checked from (1.21) that $x_{i,t+1}$ is increasing in $b_{i,t+1}$ (see appendix 1.9). This bubble process therefore fosters competition in the industry and forces the leader to expand. He will do so up to the point that prevents the followers from entering in the market. Figure 1.3 shows the output and price of good i as a function of the industry bubble $b_{i,t+1}$. Naturally, as $b_{i,t+1}$ rises total output increases and the price decreases. But as the new bubble gets too large, $p_{i,t+1}$ will fall short of the leader's marginal cost of production R_{t+1} and profits become negative. Therefore, this bubble process may lead to a situation of excessive investment and corporate losses as in some of the bubbly episodes described in section 1.6.



Parameters: $\alpha = 0.5$, $\rho = 0.5$, $\pi = 0.8$ and $r = 0.95$

Figure 1.3: Industry-level Bubble

Multiplicative Bubbles

In the example described above, competition for a fixed industry bubble forces the leader to expand. The total size of the industry bubble was independent of output. Suppose however that instead of taking a fixed size, each firm can create a new bubble in proportion to revenues. In particular, assume that entrepreneur $j \in [0,1]$ in industry $i \in [0,1]$ can create a bubble with size

$$b_{i,t+1}^{j} = \theta_i^j \cdot p_{i,t+1} \cdot x_{i,t+1}^{j}$$

with $\theta_i^j \geq 0$. This process is not unreasonable given that valuation is often based on multiples of revenues (as discussed before). The constant θ_i^j is allowed to differ across types. This is done mainly for theoretical clarity, because bubbles may have different effects depending on who creates them.

Let us start by looking at an equilibrium with $\theta_i^L > 0$ and $\theta_i^F = 0$ (i.e. only the leader can create bubbles). In this case, if he had no competitors, the leader would produce

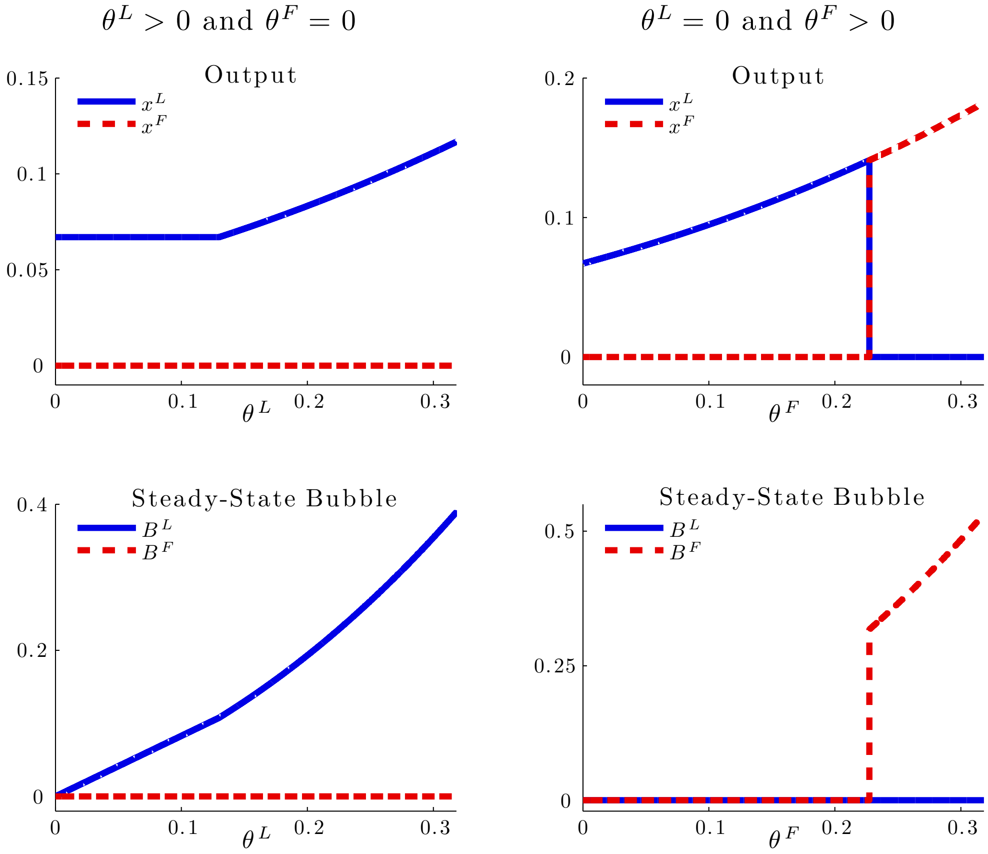
$$x_{i,t+1}^{L} = \left[\left(1+\theta_i^L\right)\frac{\rho \cdot \alpha}{R_{t+1}}\right]^{\frac{1}{1-\rho}} K_{t+1}^{\frac{\alpha-\rho}{1-\rho}} \tag{1.22}$$

Note however that if $\left(1+\theta_i^L\right)\cdot\rho \leq \pi$, this value is lower than the quantity in (1.9), implying that the followers can profitably enter. Therefore, when $\left(1+\theta_i^L\right)\cdot\rho \leq \pi$ the bubble will have no effect in terms of economic activity. The reason is that the leader always needs to produce at least the quantity in (1.9) to keep the followers out of the market. The bubble only leads to an increase in output when $\left(1+\theta_i^L\right)\cdot\rho > \pi$. In this case, the leader produces the quantity given by (1.22). This is shown in the left panels of Figure 1.4.

Let us now look at an equilibrium with $\theta_i^L = 0$ and $\theta_i^F > 0$. In this case, the followers will enter in the market if

$$p_{i,t+1} > \underline{p}_{i,t+1}\left(\theta_i^F\right) \equiv \frac{1}{1+\theta_i^F}\frac{R_{t+1}}{\pi}$$

Therefore, to keep the followers out of the market the leader must produce a sufficiently large quantity such that $p_{i,t+1} = \underline{p}_{i,t+1}\left(\theta_i^F\right)$. Of course, he can only do so as long as he does not incur in a loss, which happens if $\left(1+\theta_i^F\right)\pi \leq 1$. Note that in this case the followers will not produce and no bubble will appear! This is a situation in which there is a *latent* bubble: if the followers were to produce, a bubble would materialize. However, the leader optimality expands production to the point in which it is not profitable for the followers to enter. This example therefore provides a theory for sentiment-driven business cycles even when prices do not depart from fundamentals. Finally note that if $\left(1+\theta_i^F\right)\pi > 1$ and $\theta_i^L = 0$, the followers produce and dethrone the leader.



Parameters: $\alpha = 0.5$, $\rho = 0.7$, $\pi = 0.8$ and $r = 0.9$

Figure 1.4: Multiplicative Bubble: leader *versus* followers

1.3.2 General Equilibrium

I will look at symmetric equilibria in which all industries are subject to identical bubble processes

$$b_{i,t+1}^z = b_{t+1}^z,\ \forall i \quad \text{and} \quad z \in \{L, F\}$$

In this case, all industries produce the same output which will be a negative function of the interest rate

$$K_{t+1} = x_{i,t+1} = f(\underset{(-)}{R_{t+1}}),\ \forall i$$

The exact functional form $f(\cdot)$ will depend on the assumptions about the creation of new bubbles. If only the leaders produce, equilibrium in the credit market requires that

$$R_{t+1} = \max\left\{f^{-1}\left[(1-\alpha)\cdot K_t^{\alpha} - B_t\right], r\right\}$$

To understand the previous equation note that when all savings are intermediated

$$\underbrace{f\left(R_{t+1}\right)}_{\text{investment}} + \underbrace{B_t}_{\text{bubble}} = \underbrace{(1-\alpha)\cdot K_t^{\alpha}}_{\text{savings}}$$

Therefore, as long as $R_{t+1} = r$, bubbles crowd out storage and will not be contractionary. However, if $R_{t+1} > r$ bubbles will crowd out investment and will be contractionary. To conclude, I must characterize the bubble dynamics. In equilibrium, the return on existing bubbles must equal the interest rate. There will also be new bubbles being created in every period. Therefore, we observe the following law of motion

$$B_{t+1} = R_{t+1}\cdot B_t + \int_{j\in[0,1]}\int_{i\in[0,1]} b_{i,t+1}^{j}$$

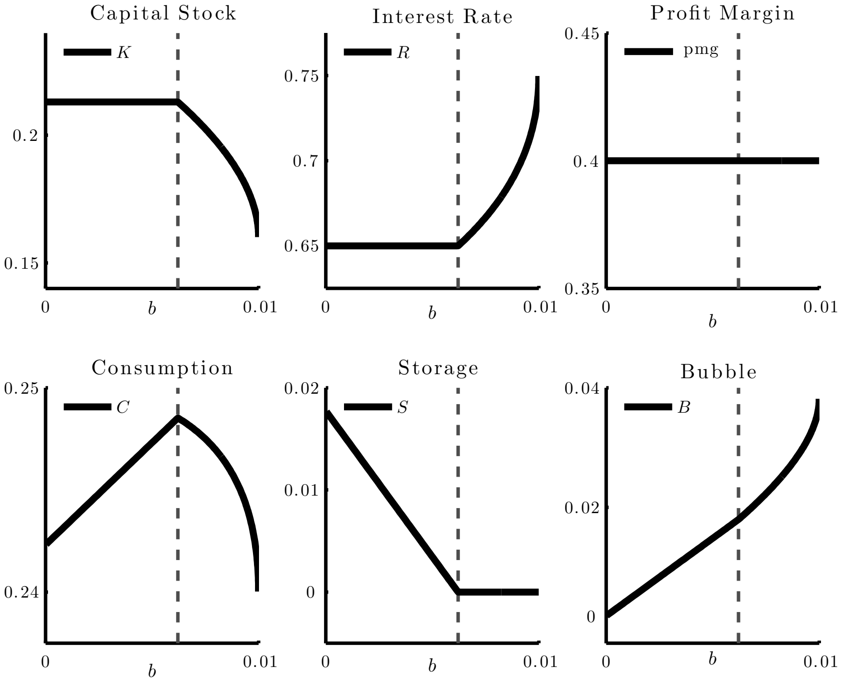
The remaining of this section characterizes the steady-state of this economy under the different bubble processes considered above.

Constant Bubbles at the Firm Level

If each individual entrepreneur is able to create a bubble with size $b_i^j = b$, aggregate investment and output will not change when as long as $R^* = r$. In such case, the bubble just absorbs resources from storage and the economy will still converge to $K^* = \left(\frac{\pi\cdot\alpha}{r}\right)^{\frac{1}{1-\alpha}}$ as in the bubbleless equilibrium. However, the bubble introduces an efficient intergenerational allocation of resources, as it crowds out investment from the low-return storage technology. As a result, aggregate consumption increases even when output remains constant (see Figure 1.5).

When the bubble gets too large, storage is no longer used and $R^* > r$. In this case, the bubble diverts away resources from investment and leads to a contraction of output. The steady-state capital stock is implicitly defined by

$$K + \frac{b}{1 - \pi \cdot \alpha \cdot K^{\alpha-1}} = (1 - \alpha) \cdot K^{\alpha}$$



Parameters: $\alpha = 0.5$, $\pi = 0.6$ and $r = 0.65$

Figure 1.5: Constant Firm Bubble in All Industries

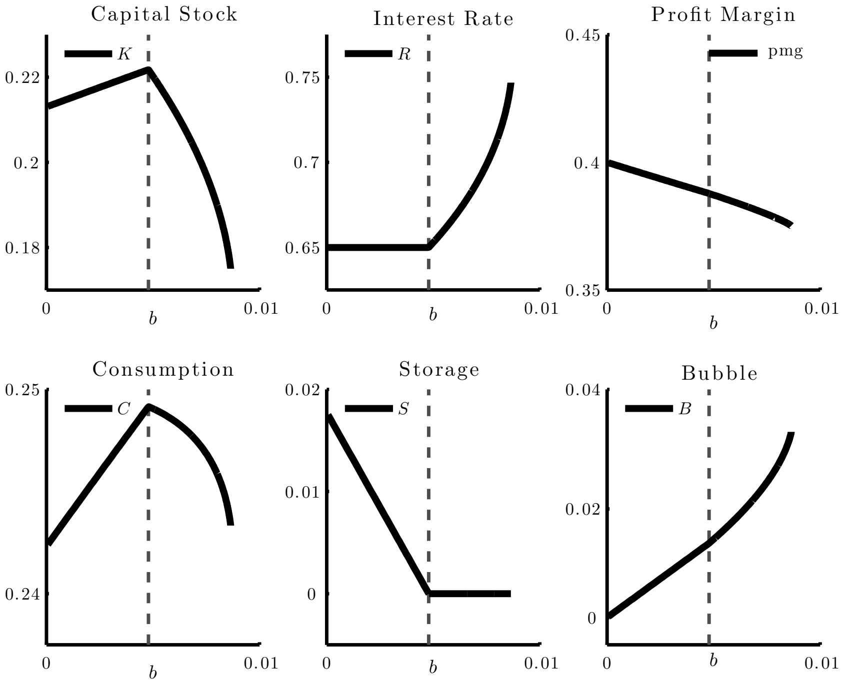
Constant Bubbles at the Industry Level

In this case, the capital stock K is determined implicitly by

$$\alpha \cdot K^{\alpha-1} = \frac{R}{\pi} - \frac{b}{K} \tag{1.23}$$

It is easy to verify that the bubble is expansionary as long as $R_{t+1} = r$ (see proof in appendix 1.9). As before, if $R_{t+1} > r$ storage stops being used and the bubble becomes contractionary. A steady-state of this economy as a function of b

is represented in Figure 1.6. As we can see, there is an expansionary region when b is small.



Parameters: $\alpha = 0.5$, $\pi = 0.6$ and $r = 0.65$

Figure 1.6: Industry Bubble in All Industries

Multiplicative Bubbles

First let us focus on equilibria with $\theta^L = 0$ and $\theta^F > 0$: only the followers create bubbles. In this case

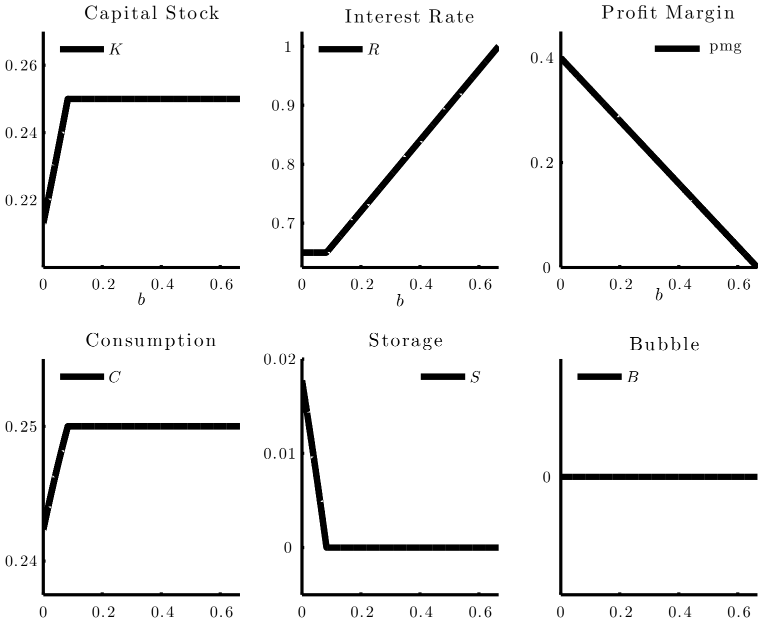
$$K_{t+1} = x_{i,t+1} = \left[\frac{\alpha \cdot \pi \left(1 + \theta^F\right)}{R_{t+1}}\right]^{\frac{1}{1-\alpha}}$$

If θ^F is sufficiently small, expectations about the formation of bubbles by the followers force the leaders to expand. This results in additional capital formation and a contraction of storage. This happens as long as

$$1 + \theta^F \leq \frac{1-\alpha}{\alpha}\frac{r}{\pi}$$

Once storage stops being used, the interest rate increases with θ^F but the capital stock does not decline. This happens because we are always in a situation of a latent bubble: as θ^F rises, the demand for funds increases; however, since no bubble materializes, the supply of funds is fixed and all the adjustment occurs through the interest rate. Under this version of the model, economies with identical levels of capital stock and no bubbles can nevertheless have different interest rates due to pure expectations about the appearance of new bubbles. A steady-state of this economy is represented in Figure 1.7.

It can be shown that in this symmetric equilibrium the followers will never produce even if $\theta^L = 0$. This happens because when $\alpha \geq 0.5$ (investment is efficient), the minimum bubble that allows the followers to enter requires an interest rate greater than one.[15]



Parameters: $\alpha = 0.5$, $\pi = 0.6$ and $r = 0.65$

Figure 1.7: Multiplicative Bubble on the Followers

Now let us look at equilibria with $\theta^L > 0$ and $\theta^F = 0$. In this case only the

---

[15] When no storage is used, equilibrium in the credit market requires$R = \frac{\alpha}{1-\alpha}\left(1+\theta^F\right)\pi$. Given that $\alpha \geq 0.5$, $\left(1+\theta^F\right)\pi \geq 1$ requires $R \geq 1$ which precludes the appearance of bubbles.

leaders create bubbles and

$$K = \max\left\{\left[\left(1+\theta^{L}\right)\frac{\alpha\cdot\rho}{R}\right]^{\frac{1}{1-\alpha}}, \left(\frac{\alpha\cdot\pi}{R}\right)^{\frac{1}{1-\alpha}}\right\}$$

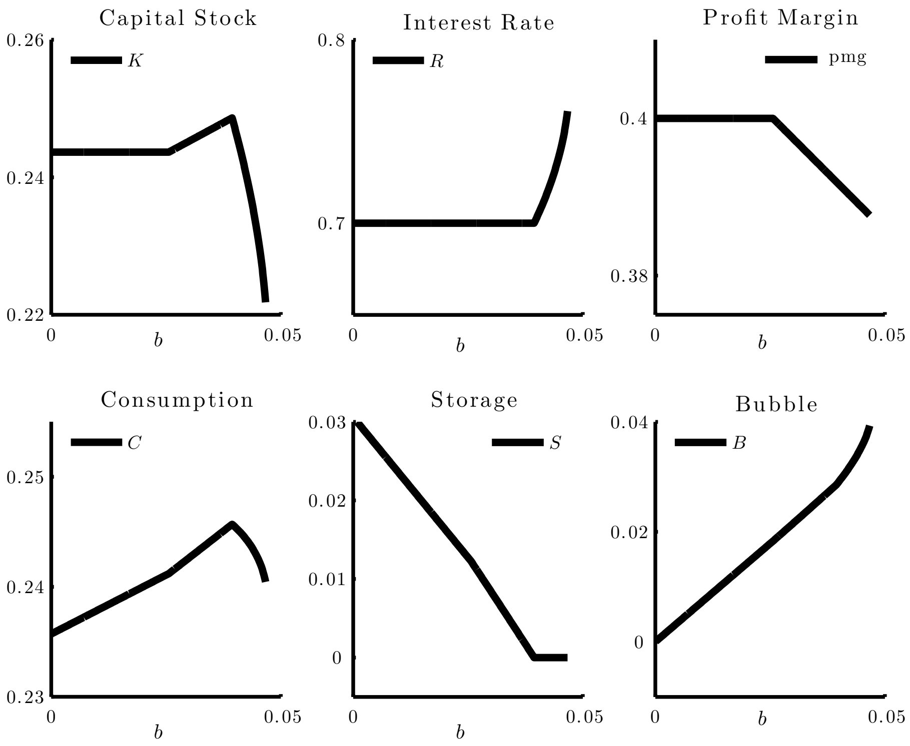
Recall that the bubble is expansionary only when $\left(1+\theta_i^{L}\right)\cdot\rho > \pi$. The minimum (steady-state) expansionary bubble is

$$B = \frac{1}{1-R}\cdot\frac{\pi-\rho}{\rho}\cdot\alpha K^{\alpha}$$

For this bubble to be possible when storage is built, we need

$$K + \frac{1}{1-R}\cdot\frac{\pi-\rho}{\rho}\cdot\alpha K^{\alpha} \leq (1-\alpha)\,K^{\alpha}$$

As we can see from this equation, bubbles can be expansionary only when ρ is high enough (i.e. when firms have low market power). This is represented in Figure 1.8.



Capital Stock

Interest Rate

Profit Margin

Consumption

Storage

Bubble

Parameters: $\alpha = 0.5$, $\pi = 0.6$ and $r = 0.7$

Figure 1.8: Multiplicative Bubble on the Leaders

1.4 Financial Frictions

Most papers analyzing the macroeconomic consequences of asset bubbles have focused on credit market imperfections. I have however taken a different perspective and focused on the workings of product markets. In this section, I will introduce financial frictions and discuss how it can affect product market competition. Following the literature, I will consider a limited pledgeability problem and assume that the institutional framework is such that borrowers can only pledge a fraction $\phi \in (0,1)$ of revenues. However, they can pledge entirely all the bubbles they can create. Furthermore, I shall assume that the credit market is segmented across industries, so that an entrepreneur cannot collateralize his borrowing in one industry against his revenues (or bubbles) in other industries.[16] Let $g^j_{i,t}$ denote the funds raised by entrepreneur j at time t in industry i. Then, we must observe the following credit constraint

$$R_{t+1} \cdot g^j_{i,t} \leq \phi \cdot p_{i,t+1} \cdot x^j_{i,t+1} + b^j_{i,t+1} \tag{1.24}$$

As we shall see, an interesting interplay between financial frictions and imperfect competition will emerge: financial frictions may affect disproportionately more the followers and hence exacerbate the lack of competition in product markets. Indeed, absent the formation of bubbles and if the pledgeability parameter ϕ is not too low (see conditions below), only the followers will face a binding credit constraint.

In this setup, bubbles will play a new role as they can serve as a source of collateral and hence allow constrained entrepreneurs to increase their borrowing. This is the channel considered in several recent models, such as Martin and Ventura [2011, 2012, 2016] and Tang [2017]. However, even when they simply provide collateral (and not the sort of production subsidy considered in the previous section) bubbles may still have a pro-competitive effect. This is what happens if the followers are constrained, but the leader is unconstrained. In such case, bubbles will relax the constraint faced by the followers. However, as the followers can borrow and invest more, the unconstrained leader will be forced to expand.

---

[16] This last assumption, being not unrealistic, renders the analysis simple and clear. It could naturally be relaxed, but at the expense of extra complexity and no interesting insight.

1.4.1 Moderate Financial Frictions: $\phi \cdot \pi > \rho$

As before, let us focus on an arbitrary industry $i \in [0,1]$. Before introducing bubble creation, I will characterize the industry equilibrium with no bubbles.

Bubbleless Equilibrium

Let us start by assuming that in industry i the leader was granted a monopoly. In this case, if the constraint in (1.24) does not bind, he produces

$$x_{i,t+1} = \left(q_{t+1} \cdot \frac{\rho}{R_{t+1}}\right)^{\frac{1}{1-\rho}} K_{t+1}$$

If the leader cannot invest such amount, this is because the constraint binds.[17] In such case, he can only invest

$$x_{i,t+1} = \left(q_{t+1} \cdot \frac{\phi}{R_{t+1}}\right)^{\frac{1}{1-\rho}} K_{t+1}$$

A direct comparison of these two quantities implies that as long as $\phi > \rho$, the leader is unconstrained if facing no competition. However, as long as $\phi \cdot \pi > \rho$ (which I will assume throughout), we have

$$p_{i,t+1} = q_{t+1} \cdot \left(\frac{K_{t+1}}{x_{i,t+1}}\right)^{1-\rho} = \frac{R_{t+1}}{\rho} > \frac{R_{t+1}}{\phi \cdot \pi}$$

implying that the followers are able and willing to enter in the industry.[18] This forces the leader to expand and produce the quantity that guarantees $p_{i,t+1} = \frac{R_{t+1}}{\phi \cdot \pi}$. Therefore, in the absence of bubbles, we have that

$$x_{i,t+1} = \left(\frac{\alpha \cdot \pi \cdot \phi}{R_{t+1}}\right)^{\frac{1}{1-\rho}} K_{t+1}^{\frac{\alpha-\rho}{1-\rho}} \tag{1.25}$$

$$p_{i,t+1} = \frac{R_{t+1}}{\phi \cdot \pi} \tag{1.26}$$

These two equations characterize the industry equilibrium when $\phi \cdot \pi > \rho$ and there are no bubbles. These are the natural counterparts of equations (1.9) and

---

[17] In this case we have $R_{t+1} \cdot x^L_{i,t+1} = \phi \cdot p_{i,t+1} \cdot x^L_{i,t+1}$.

[18] It is to see that the followers will enter as long as $p_{i,t+1} > \frac{R_{t+1}}{\phi \cdot \pi}$.

(1.10), which are obtained as the limiting case when $\phi \to 1$. As we can see, financial frictions exacerbate the degree of imperfect competition: given $\phi \cdot \pi > \rho$, the lower is ϕ, the higher the price charged by the leader. To sum up, as long as $\phi \cdot \pi > \rho$, the leader will be unconstrained. Still, he will need to expand beyond the desired monopoly quantity to prevent the entry of the followers.

Constant Bubbles at the Firm Level

Since I am interested in studying the role of bubbles as a source of collateral, I will just focus on constant-firm level bubbles.[19] Assume that all entrepreneurs can create a bubble with constant size $b_{i,t+1} > 0$. How would this bubble affect the industry equilibrium? Clearly, as long as $p_{i,t+1} > \frac{R_{t+1}}{\pi}$ the followers want to invest. We must therefore ask under what conditions the price is strictly above the followers' marginal cost of production. First note that as long as $\phi \geq \pi$, the leader can always keep the followers out of the market (I will assume this condition holds). This is because the financial friction is not extremely severe so that the leader can borrow and invest the amount that guarantees $p_{i,t+1} = \frac{R_{t+1}}{\pi}$ even when $b_{i,t+1} = 0$.

Suppose now that $b_{i,t+1}$ is sufficiently high so that the followers are unconstrained. In this case, the leader will produce

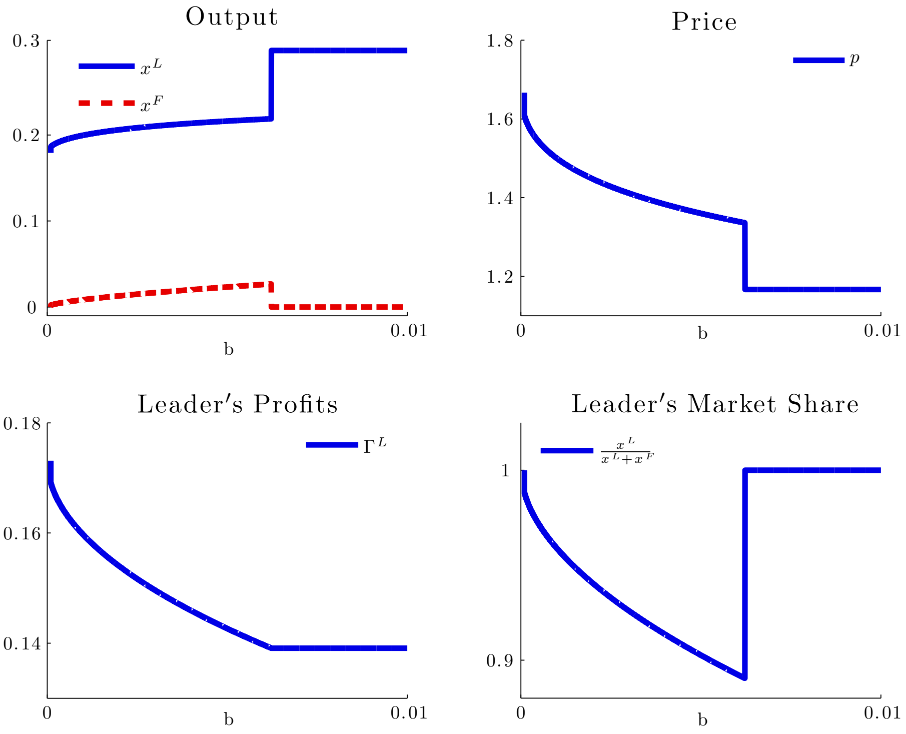
$$x^L_{i,t+1} = \bar{x}_{i,t+1} \equiv \left(\frac{\alpha \cdot \pi}{R_{t+1}} \right)^{\frac{1}{1-\rho}} K_{t+1}^{\frac{\alpha-\rho}{1-\rho}}$$

in order to guarantee $p_{i,t+1} = \frac{R_{t+1}}{\pi}$. In this case, the followers just create empty firms to appropriate the bubble creation rents: these however force the leader to increase production. On the other hand, when $b_{i,t+1}$ is sufficiently small the leader will prefer to produce a quantity lower than $\bar{x}_{i,t+1}$ and accommodate the entry of the followers. In this case, we observe $p_{i,t+1} > \frac{R_{t+1}}{\pi}$ and the followers face a binding credit constraint. The characterization of the solution can be found in appendix 1.10.

---

[19] The alternative processes considered in section 1.3 (industry bubbles and multiplicative bubbles) will not provide any major insight in this context. If credit constraints are binding, bubbles will still serve as a source of collateral.

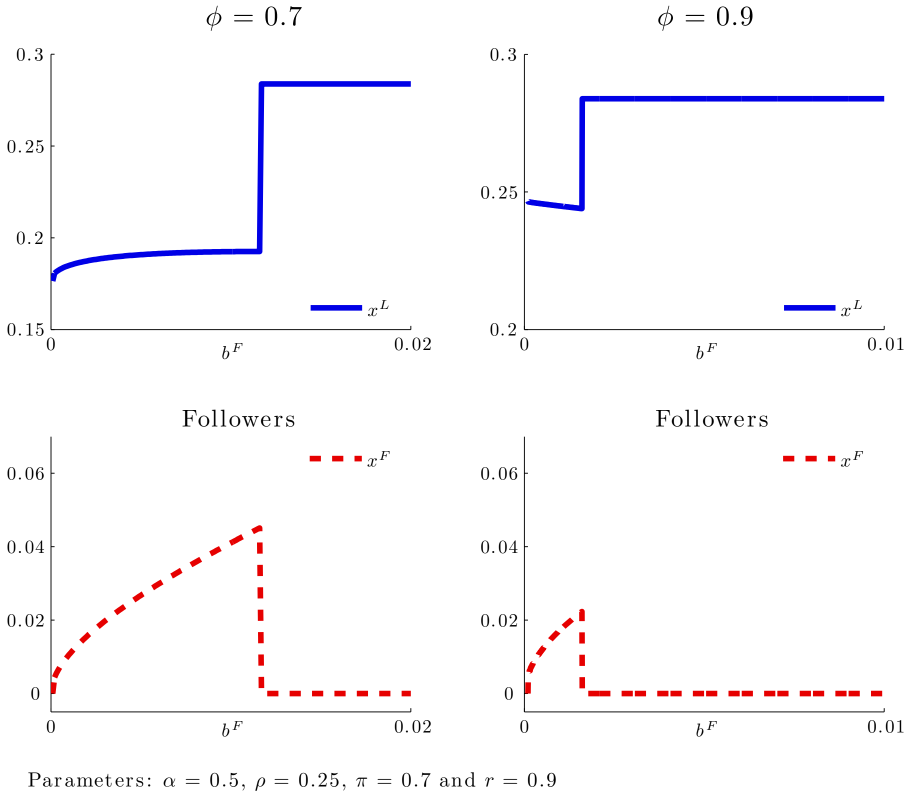
Figure 1.9 shows some equilibrium variables as a function of $b_{i,t+1}$. When $b_{i,t+1}$ is sufficiently small, the leader lets the followers enter. As $b_{i,t+1}$ increases, the profits of the leader decrease, as the industry price falls. When $b_{i,t+1}$ gets too large, the leader will prefer to raise his output to $\bar{x}_{i,t+1}$ and keep the followers out of the market. When choosing whether to accommodate the entry of the followers, the leader faces a trade-off. On the one hand, by letting the followers enter, he will have a lower market share, but may charge a high price. If he decides to impede the entry of the followers, he can instead have a high market share (indeed a monopoly) but with a low price. This is shown in the second and fourth panels of Figure 1.9.



Parameters: α = 0.5, ρ = 0.3, π = 0.6, r = 0.7 and ϕ =0.7

Figure 1.9: Constant Bubble with Financial Frictions

In the example depicted in Figure 1.9, the leader always expands in reaction to the creation of bubbles (by the followers). However, this does not need to be always the case. As shown in Figure 1.10, if ϕ is large enough and $b_{i,t+1}$ is low, the leader may accommodate the entry of the followers and reduce output when a bubble appears. This happens because when ϕ is high, even a small bubble allows the constrained followers to produce a large quantity. In such case, bubbles lead to a market inefficiency: the productive firm contracts, and the unproductive constrained firms expand. However, given that $\phi \geq \pi$, as $b_{i,t+1}$ gets too large the leader will prefer to produce the quantity that guarantees $p_{i,t+1} = \frac{R_{t+1}}{\pi}$ in order to keep the whole market.



Parameters: $\alpha = 0.5$, $\rho = 0.25$, $\pi = 0.7$ and $r = 0.9$

Figure 1.10: Constant Bubble with Financial Frictions

1.4.2 General Equilibrium

Bubbleless Economy

We can combine equations (1.3) and (1.25) to find that

$$K_{t+1} = \left(\frac{\alpha \cdot \pi \cdot \phi}{R_{t+1}} \right)^{\frac{1}{1-\alpha}} \tag{1.27}$$

This economy will have the following law of motion

$$K_{t+1} = \min \left\{ (1-\alpha) \cdot K_t^{\alpha}, \left(\frac{\alpha \cdot \pi \cdot \phi}{r} \right)^{\frac{1}{1-\alpha}} \right\} \tag{1.28}$$

$$R_{t+1} = \phi \cdot \alpha \cdot \pi \cdot K_{t+1}^{\alpha-1} \tag{1.29}$$

and will converge to a steady-state given by

$$K^* = \min \left\{ (1-\alpha)^{\frac{1}{1-\alpha}}, \left(\frac{\alpha \cdot \pi \cdot \phi}{r} \right)^{\frac{1}{1-\alpha}} \right\} \tag{1.30}$$

$$R^* = \max \left\{ \frac{\phi \cdot \alpha \cdot \pi}{1-\alpha}, r \right\} \tag{1.31}$$

As it can be seen from equations (1.29) and (1.31), the presence of financial frictions puts additional downward pressure on the interest rate. When storage is not used in the steady-state, the condition for the existence of rational bubbles is

$$\alpha < \frac{1}{1 + \phi \cdot \pi} \tag{1.32}$$

It can be easily checked that the condition for dynamic efficiency is the same as before, namely

$$\alpha \geq \frac{1}{2} \tag{1.33}$$

Therefore, when ϕ and π are not simultaneously too high, rational asset bubbles will still be possible even when capital accumulation is dynamically efficient.

Finally, note that storage will be used in the steady-state if

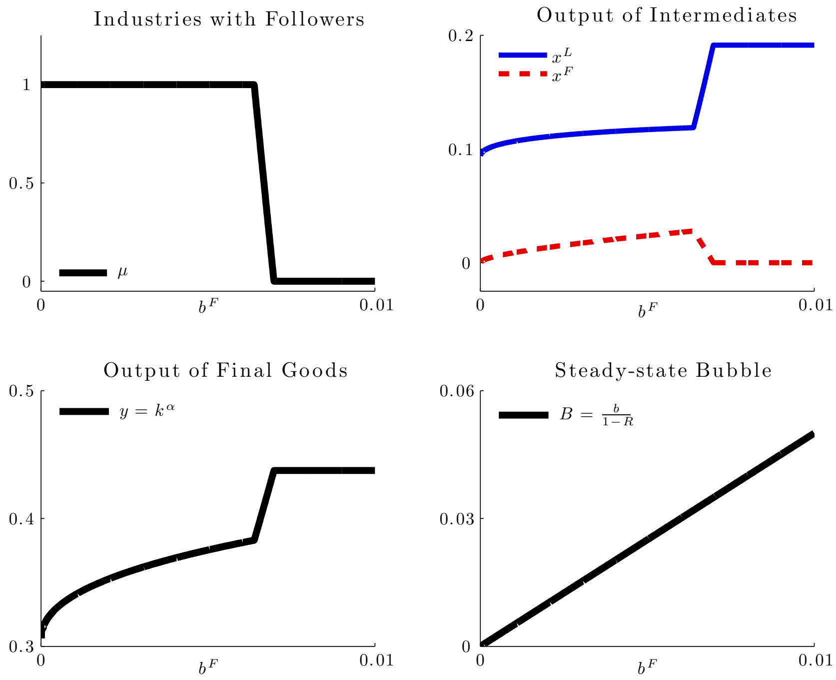
$$r > \frac{\phi \cdot \alpha \cdot \pi}{1-\alpha}$$

As before, I will focus on a parameter space under which the economy is dynamically efficient, but storage is built (so that there is underinvestment). This happens if

$$\frac{1}{2} < \alpha < \frac{r}{\phi \cdot \pi + r} \tag{1.34}$$

Constant Bubbles at the Firm Level

Assume that in every industry firms can create a bubble with size $b_i = b \geq 0 \quad \forall i \in [0,1]$ that is not linked to the industry's output. Appendix 1.10 describes how the equilibrium is determined. When b is low, there is a symmetric equilibrium in which all industries accommodate the entry of the followers. On the other hand, when b is high, the leaders impede the entry of the followers in all industries. As it can be seen in Figure 1.11, such symmetric equilibrium does not exist for intermediate values of b. In this case, the followers are able to enter in a fraction $\mu \in (0,1)$ of the industries. In such industries, the leaders have a low market share, but charge a high price. In the industries in which the followers are unable to enter, the price is low but the leaders have a high market share (indeed they have the whole market). Figure 1.11 also represents the equilibrium output of intermediates and aggregate output as a function of b.[20]


Industries with Followers

Output of Intermediates

Output of Final Goods

Steady-state Bubble

Parameters: $\alpha = 0.5$, $\rho = 0.25$, $\pi = 0.7$, $r = 0.8$ and $\phi = 0.7$

Figure 1.11: Constant Bubble with Financial Frictions (General Equilibrium)

---

[20] For the case $\mu \in (0,1)$, the corresponding averages are plotted.

1.5 Endogenous Growth

So far, I have focused on a static setup. I assumed that there was a constant set of intermediate goods $I = [0, 1]$ at all points in time. Under such framework, shocks to bubble creation could lead to fluctuations in output, but they could never generate sustained, long-run growth. However, it might be interesting to think of a setup with endogenous product variety and determine the conditions under which the emergence of bubbles can boost or hinder growth. In order to do so, I will assume that entrepreneurs must choose between two different occupations: the production of existing intermediate varieties or the invention of new ones. This extension will offer new insights. Bubbles in existing sectors, if increasing competition and lowering their profitability, can foster the creation of new products/industries. However, bubbles appearing in new industries may inhibit their development: this happens if the increase in competition in these industries (which lowers profits) more than offsets the bubble creation return.

1.5.1 The Model with Increasing Varieties

Consider an economy similar in preferences and technology to the one described in Section 1.2. The main difference concerns the number of intermediates input varieties. Let $M_{t+1} \geq 1$ be the number of intermediate input varieties that are available at time $t + 1$. Equation (1.3) will be replaced by

$$K_{t+1} = \left(\int_0^{M_{t+1}} x_{i,t+1}^{\rho} \, di \right)^{\frac{1}{\rho}} \tag{1.35}$$

I will refer to $I_{t+1} \equiv [0, M_{t+1}]$ as the set of intermediate varieties produced at time $t + 1$. Some of these goods were invented before time t: these are the *old* industries $[0, M_t]$. Other varieties are invented at time t: these are the *new* industries $[M_t, M_{t+1}]$. The assumptions about the distribution of productivity types need also to be generalized. It will be useful to define

$$S_t^j \equiv \left\{ i \in I_t \, : \, \pi_{i,t}^j \geq \pi_{i,t}^l \quad \forall l \in [0, 1] \right\}$$

as the set of *old* varieties for which entrepreneur $j \in [0,1]$ is the most efficient producer. I will assume that in all *old* industries $i \in I_t$

$$\pi^j_{i,t} = \begin{cases} 1 & \text{if} \quad i \in S^j_t \\ \pi < 1 & \text{if} \quad i \notin S^j_t \end{cases} \tag{1.36}$$

Furthermore, I impose that *(i)* $S^j_t \cap S^h_t = \emptyset$ if $j \neq h$ and that *(ii)* $I_t = \bigcup\limits_{j \in [0,1]} S^j_t$. Given these assumptions, in each *old* industry there is one and only one leader. I also require that each set S^j_t has infinitesimal measure, so that no individual entrepreneur can affect aggregate variables.

Entrepreneurs producing *old* varieties receive profits in the industries in which they are leaders. Alternatively, entrepreneurs can engage in innovation. Innovation consists in the invention and production of new varieties. Entrepreneurs differ however in their ability to invent new varieties. At time t, an innovator $j \in [0,1]$ may discover a number z^j_t of new varieties according to a technology

$$z^j_t = \lambda \cdot M_t \cdot j^{-\delta} \quad , \delta \in (0,1) \tag{1.37}$$

where λ reflects the average efficiency of innovation and M_t is the number of varieties invented prior to time t. According to this specification, the more advanced the technological frontier is, the easier it is to innovate. Furthermore, low index entrepreneurs are assumed to be more efficient in innovation. If an entrepreneur decides to innovate, he will be the leader in the new industries that he invents. However, he cannot produce in the old industries S^j_t in which he is the most efficient produce: these are taken by the followers. This will be a critical assumption but will offer interesting insights.

1.5.2 Equilibrium

Let n_t be the number of entrepreneurs who innovate at time t. Given the innovation technology in (1.37), all entrepreneurs $[0, n_t]$ innovate. The technology frontier evolves according to

$$M_{t_{+1}} = M_t + \int_0^{n_t} \lambda \cdot M_t \cdot j^{-\delta} \, dj \tag{1.38}$$

All we need to determine is the fraction n_t of entrepreneurs who innovate. In what follows, I will allow for the existence of multiplicative bubbles (this particular process is chosen just for analytical convenience). I will distinguish between bubbles attached to *old* versus to *new* industries. As before θ^L and θ^F will refer to bubbles created by the leaders and the followers in *old* industries. φ^L and φ^F will refer to bubbles created by the leaders and the followers in *new* industries.

Note that each entrepreneur can be a leader in a measure M_t of *old* industries.[21] Moreover, if he innovates he will produce in a number $\lambda \cdot M_t \cdot n_t^{-\delta}$ of *new* industries. Therefore, in equilibrium we should observe the following indifference condition for the marginal innovator n_t[22]

$$\left(\frac{1}{\pi}\frac{1+\theta^L}{1+\theta^F}-1\right)\cdot\left(1+\theta^F\right)^{\frac{1}{1-\rho}}=\left(\frac{1}{\pi}\frac{1+\varphi^L}{1+\varphi^F}-1\right)\cdot\left(1+\varphi^F\right)^{\frac{1}{1-\rho}}\cdot\lambda\cdot n^{*-\delta} \tag{1.39}$$

This equations pins down the number of innovators n_t. It says that the marginal innovator n_t must be indifferent between producing old or new varieties. It is easy to see that the number of innovators increases with both φ^L and θ^F, but decreases with both θ^L and φ^F.[23] φ^L increases the return on new industries for the innovating leaders and stimulates growth. This is the subsidy channel already highlighted by Olivier [2000]. θ^F stimulates the creation of new industries through a different channel: by increasing competition in old industries and reducing their profitability, bubbles make new industries relatively more appealing and promote growth. On the other hand, θ^L increases the return on existing industries for the leaders, making new ones relatively less appealing and discouraging innovation. Similarly φ^F increases competition in new industries and makes them relatively less attrac-

---

[21] The ones invented prior to time t.

[22] In period $t+1$, the profits a leader can make in an old and a new industry are respectively given by

$$\left[\left(1+\theta^L\right)\cdot\frac{R_{t+1}}{\pi\left(1+\theta^F\right)}-R_{t+1}\right]\cdot\left[\frac{\alpha\cdot\pi\left(1+\theta^F\right)}{R_{t+1}}\right]^{\frac{1}{1-\rho}}K_{t+1}^{\frac{\alpha-\rho}{1-\rho}}$$

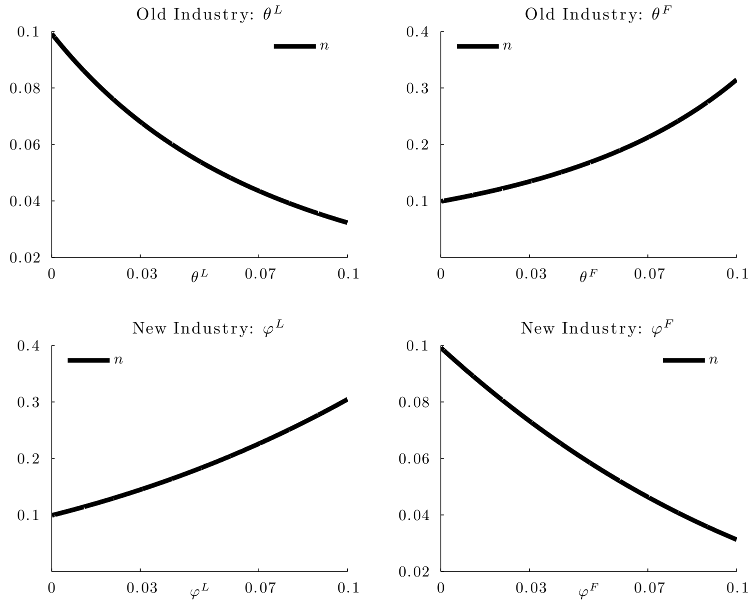
$$\left[\left(1+\varphi^L\right)\frac{R_{t+1}}{\pi\left(1+\varphi^F\right)}-R_{t+1}\right]\cdot\left[\frac{\alpha\cdot\pi\left(1+\varphi^F\right)}{R_{t+1}}\right]^{\frac{1}{1-\rho}}K_{t+1}^{\frac{\alpha-\rho}{1-\rho}}$$

[23] Under the assumptions that $\left(1+\theta^L\right)\cdot\rho\leq\pi$ and $\left(1+\varphi^L\right)\cdot\rho\leq\pi$, so that the leaders always need to set a limit price.

tive for the leaders. Here, the competition channel has the opposite effect: by reducing the profitability of new sectors, bubbles reduce the returns to innovation and growth. Figure 1.12 shows the equilibrium number of innovators as a function of θ^L, θ^F, φ^L and φ^F (in each case, only one type of bubble exists and storage is built in equilibrium). Under these assumptions the economy will experience a balanced growth path. The growth rate can be obtained by combining equations (1.38) and (1.39):

$$\frac{M_{t+1}}{M_t} = 1 + \lambda \frac{n^{*1-\delta}}{1-\delta} \tag{1.40}$$

This extension puts the competition channel that is at the center of the model in a dynamic perspective. As it was shown, asset bubbles can intensify product market competition and reduce monopoly rents. This may bring not only static gains (stemming from an increase in output), but also dynamic benefits: if they reduce the profitability of existing sectors, bubbles can foster the creation of new ones. However, under this dynamic perspective the competition channel also poses a risk: if they reduce the profitability of new sectors, bubbles will hinder their development.



$\rho = 0.1$, $\pi = 0.75$, $\delta = 0.3$ and $\lambda = 0.5$

Figure 1.12: Endogenous Growth

1.6 Competition in Famous Bubbly Episodes

Stock market boom/bust episodes are recurring phenomena in financial history. Famous examples include the Mississippi and the South Sea bubbles of 1720, the British *railway mania* of the 1840s or more recently the *dotcom bubble* of the late 1990s.

In this section, I provide a brief description of two of these episodes - the British *railway mania* of the 1840s and the *dotcom* bubble of the late 1990s - and discuss how they can be reinterpreted in light of the theory developed above.

1.6.1 The British Railway *Mania* of the 1840s

Figure 1.13: British Railway Share Price Index, 1843-1850
(Source: Campbell and Turner [2015])

The mid 1840s was a period of fast economic growth in Britain: favorable weather conditions (resulting in abundant harvests), together with historically low interest rates made Britain's GDP grew at an average of rate of 4.6% between 1843 and

1845. It was within this environment that a collective enthusiasm about railways emerged. Contrarily to the majority of other countries, where the construction of railway lines was essentially a public investment, the expansion of the British railway system was financed by private companies and individuals. This widespread excitement attracted many new investors to the stock market and triggered a boom in stock prices: between January of 1843 and October of 1845, the share prices of railway companies increased by more than 100% (Campbell and Turner [2010]).[24] At the same time, investment shot up: total investment in new railway lines authorized by the British Parliament rose by an average of £4 million per year prior to 1843, to £60 million in 1845 and £132 million in 1846 (Haacke [2004]).[25] Even though not all investments granted Parliament authorization would ever materialize, total capital formation by railway companies reached £30 million in 1846 and £44 million and in 1847, which represented 5.2% and 7.3% of the British GDP respectively. By comparison, during the *dotcom* bubble of the late 1990s, total US investment in technological industries reached a maximum of 2.8% of GDP in the year 2000.[26] Given the magnitude of these investments, the British railway mania has been referred to as "arguably the greatest bubble in history".[27]

Such collective enthusiasm would however cease in the middle of the decade. A recession in 1845, associated with failure of the potato crops in Ireland, led many people to fear times of famine and scarcity. At the same time, the escalation of construction costs resulted in substantial calls for capital from railway shareholders.[28] Several projects ended up being less profitable than expected. Many commentators and newspapers (such as the recently founded *The Economist*) also

---

[24] Individual investors financing railway projects around this time include famous scientists, intellectuals and politicians such as Charles Darwin, Charles Babbage, John Stuart Mill or Benjamin Disraeli (Odlyzko [2010]).

[25] Despite being private investment, the construction of new railway lines required Parliament authorization. This happened because they often involved processes of land expropriation (Odlyzko [2010]).

[26] Data is from the Bureau of Economic Analysis. The industries considered include 'Computer and Electronic Products', 'Publishing Industries', 'Broadcasting and Telecommunications' and 'Information and Data Processing Services'.

[27] *The Economist*, "The Beauty of Bubbles", 2008/12/18.

[28] *The Economist*, "The Railway Crisis - its Cause and its Cure", 1848/10/21.

started raising concerns about the potentially negative effects of such large-scale railway investments. As a result, share prices of railway companies started to decline and between October 1845 and December 1850 the total stock market capitalization of railway companies decreased by 67% (Campbell and Turner [2010]).

The deteriorating performance of railway companies was ultimately related to an environment dominated by intense competition and, in some cases, overinvestment. The collective euphoria about railways and the demand for railway investments were so high, that "*the amounts of capital being committed to the industry made competition ever fiercer and business plans ever rosier*".[29] Not only new lines were open in relatively unprofitable regions (serving sparsely populated areas) but there were also obvious examples of duplication of railway lines. Situations of line duplication were described (and sometimes harshly criticized) by many contemporaneous authors. One example, which is described in Cotterill [1849], is the railway line that connected Shrewsbury to Stafford, which opened in 1849 and was in operation until 1966. It was ran by The Shropshire Union Railways and Canal Company, founded in 1846:

> "*The Shropshire Union Railway is another instance of the baneful principle [of competition]. It is a line from Shrewsbury to Stafford, joining the Trent Valley; and there being no intermediate traffic, the expenditure of 6 or 700,000l to effect this junction, appears prima facie to be lavish; because, if the Shrewsbury people wish to go to London, there is the Shrewsbury and Birmingham Railway, accommodating at the same time an immense intervening population. If the Shrewsbury people are desirous of moving north, the Shrewsbury and Chester, a line long since in operation, would give ample accommodation.* ***The Shropshire Union to Stafford would therefore appear to be unnecessary and useless. But it is the fruit of competition.***"

Another example involving the duplication of railway lines was the connection between Birmingham and Wolverhampton, described in Martin [1849, p.37]. In 1846, the two cities were already connected by the *Grand Junction Railway* (and

---

[29] *The Economist*, "The Beauty of Bubbles", 2008/12/18.

by water through the *Birmingham Canal*). Still, two other companies - the *London and North Western Railway* and the *Great Western Company* - were granted authorization to build two additional lines between the two cities:

> "*Three years ago, the district between Birmingham and Wolverhampton possessed a double communication for its traffic (...) by means of the Birmingham Canal and the Grand Junction Railway, each connecting the two towns. Additional Railway accommodation was, however, supposed to be desirable, and two Companies presented their rival plans to a Committee of the House of Commons for selection. Both Railways are now in the course of formation, traversing a highly valuable and thickly peopled district in* **parallel lines (at some points nearly touching each other)***, and each intended to terminate in separate stations in the centres of the two towns. At least four millions of money will thus be unprofitably sunk, in order that three lines of railway and one canal may afford a redundant accommodation to a tract some fourteen miles in length.*"

This example makes the author conclude that "*Monopoly has an ill sound: but, unless it can be proved to be incapable of regulation, **we must prefer even monopoly to competition run mad**.*"

It is interesting to note that some of the duplication of lines was undertaken by established companies, which expanded in order to prevent the appearance of new competitors. For instance, in their study of competition during the railway *mania*, Campbell and Turner [2015] found that the fraction of lines which enjoyed absolute monopoly fell from 72% in 1843 to 32% in 1850. However, when focusing on competition from other companies, the authors found that 85% of the routes had a complete monopoly in 1843, but this fell to only 66% by 1850. The idea that incumbent railway companies over-expanded and in some cases duplicated their own lines just to deter the entry of new rivals is corroborated by contemporaneous observers. For instance, an article published in 1848 in *The Economist* notes that the London and North Western Company (one of the most important railway companies of that time) had investments in the order of £7 million *"still to be expended on lines, few if any of which had been undertaken with reference to* *their own merits, but for the purpose (perhaps not an unjustifiable one) of* ***averting threatened opposition***".[30] Cotterill [1849, p.33] also refers, in a highly critical vein, that the North Staffordshire Railway built two parallel lines in the Churnet Valley to impede the appearance of other companies

> "*[*the North Staffordshire Railway*] instead of one trunk line running from Manchester to the south, it has two, viz. from Macclesfield to Colwich on the Trent Valley, and from Macclesfield to Burton, joining the Midlands;* ***this is doubly misjudging, two lines nearly parallel****. Both cannot answer, and probably one only will be worked. Competition caused it; it was a competition between the Churnet Valley and the North Staffordshire Company.*"

The over-expansion of established railway companies has indeed been a distinctive feature of the British railway *mania*. As described by Jackman [1916, p.599] in his history of the British railway system:

> "*Nothing was more common than to see a company eagerly seeking authority t****o make a branch which could only bring it loss, but which, it was feared, would cause still greater loss if it fell into the hands of a rival****. In some cases the companies ran a greater number of trains than the traffic warranted, or carried traffic, for the time being, at unremunerative rates* ***in order to take it away from their rivals.***"

Even though the examples mentioned above may constitute situations of overinvestment, one might still argue that they reflected anti-competitive practices on the part of established companies. According to such view, competition may not have increased as incumbents companies built excess capacity to protect their monopoly power. However, the evidence shows that the revenues and profits (per mile) of incumbent railway companies fell during the *mania*. Campbell and Turner [2015] report that the average revenue per mile of established companies (i.e. existing in 1843) fell from £3,603 in 1843 to £2,559 in 1850 (by 29%).

---

[30] *The Economist*, "The Publication of Railway Liabilities", 1848/11/04.

At the same time, average profits per mile dropped from £1,811 to £1,231 (by 32%). Despite the lower profitability, and confirming some of the anecdotes described above, incumbent companies expanded their capacity quite dramatically: between 1843 and 1850, the milage operated by the average incumbent company grew from 36 to 153 miles.[31]

Why did railway companies expand so quickly? What was behind "*competition run mad*", to use the words of Martin [1849, p.37]? Although different factors may have contributed to the expansion of the British railway system during the 1840s (such as a political environment highly favorable to free markets and competition),[32] these events can be rationalized by the model presented in this paper. As investors perceived railway stocks as good financial assets (whose price was likely to appreciate in the future), vast amounts of money were poured into the British railway industry. Such high demand for railway shares may have then opened the door to the appearance of new companies and lines that were not profitable from an operating point of view. That the *mania* was a time characterized by positive sentiment and speculation in railway companies is confirmed by several contemporaneous writers. For instance, keeping his critical view on the events, Martin [1849, p.40] observes that

> *"Men and women, high and low, rich and poor, entered the destructive road of which the gates were so widely opened by the Legislature,* ***in the expectation that all could suddenly become rich****; the result to many was, that the rich were impoverished, and persons without a shilling rose on their ruin.* ***Shopkeepers augmented their expenditure by hundreds, brokers and share speculators by***

---

[31] Campbell and Turner [2015] also use a short-path algorithm to find best alternative to each route and find that the number of segments with no (reasonable) substitute falls from 67% to 29% between 1843 to 1850. At the same time, the (median) additional time incurred by taking the best alternative to a particular route falls from 22% to 9%.

[32] It is important to note that the political environment in Britain at this time was highly favorable to a private market for railways. This contrasted with other countries were governments subsidized the construction of railway line or regulated tariffs (Martin [1849, p.26]). Furthermore, there was a widespread agreement about the necessity of promoting competition between railway companies to prevent monopolies. This explains for instance why the British parliament approved many railway schemes that constituted duplication of existing lines.

> ***thousands****; 332 new schemes were brought before the public down to the 30th September, 1845, involving capital to the enormous sum of £270,959,000 of which £23,057,492 would have to be deposited with the Accountant-General before Parliament would receive application for the Acts"*

In such an environment, and as the evidence above confirms, incumbent companies were forced to expand and cut profit margins in order to prevent the entry of new competitors. Seen in this way, the expansion of the British railway system may have been commanded (at least in part) by financial market sentiment. The idea that investor sentiment may drive firms' expansion at the expense of profit margins, and ultimately provide a subsidy to consumers, was a central message of the model presented in this paper. As noted by Jackman [1916, p. 602], "*although many of the railways were not profitable to their owners in yielding large financial returns they may still have been* ***beneficial to the public*** *in providing for the necessities and conveniences of traffic*".

1.6.2 The *Dotcom* Bubble of the Late 1990s

Another famous stock market boom and crash would take place in the United States one century and a half later. Associated with the appearance of the internet and in a period marked by low interest rates, the Nasdaq index increased by more than 560% between January 1995 and March 2000 (Figure 1.14). However, as in the British railway *mania* of the 1840, the widespread enthusiasm about internet companies would also cease. Concerns about the persistently negative profitability of most new internet firms and the fact that some were running out of cash (and hence needed to raise additional funds to finance their operations) marked a turning point in market sentiment. An article published in *Barron's* magazine in March 2000 sounded the alarm: "*An exclusive study conducted for Barron's by the Internet stock evaluation firm Pegasus Research International indicates that at least 51 'Net firms will burn through their cash within the next 12 months. This amounts to a quarter of the 207 companies included in our study.*" And it added "*It's no secret that most Internet companies continue to be money-burners. Of the companies in the Pegasus survey, 74% had negative cash flows. For many,* *there seems to be little realistic hope of profits in the near term.*" A natural question therefore emerged: "*When will the Internet Bubble burst?*".[33] The downturn would start in that very same month: between March 2000 and October 2002, the Nasdaq index decreased by 77%.

Figure 1.14: The Nasdaq Composite Index, 1995-2005

Behind the poor performance of so many *dotcom* firms was a search for rapid growth involving aggressive commercial practices - such as extremely low penetration prices, advertisement overspending and excess capacity - and which resulted in low levels of profitability or even extensive losses.[34] For instance, many new companies offered their services at unprofitably low prices or even for free. This was for instance common among delivery companies. *Kozmo.com* and *UrbanFetch* were two such examples - they offered one-hour delivery services of books, videos, food and other goods totally for free. Many products would even

---

[33] Jack Willoughby, "Burning Up; Warning: Internet companies are running out of cash - fast", *Barron's*, March 20, 2000

[34] See Haacke [2004] and Razi, Siddiqui and Tarn [2004] for an analysis of some of the biggest *dotcom* failures.

be sold at a discount, gifts were sometimes included and tips were not accepted. None of them survived the stock market crash in 2000.[35] The online music industry also observed many of these practices, with companies such as *CDNow.com*, *Riffage.com* or *Napster* offering downloads or peer-to-peer sharing of music for free.[36] Another example is the software company SunMicrosystems, which decided to enter in the office suite market (largely dominated by Microsoft Office) with a software that was made available completely for free (this example is reviewed in more detail below). The pressure for growth was in some cases so high that some companies would actually pay customers to use their services. One well-known example is the advertising company *AllAdvantage.com* (launched in 1999), which made famous the slogan "*Get Paid to Surf the Web*". Users of *AllAdvantage.com* needed to download a viewbar that displayed advertisements at the bottom of their screens and would be paid \$0.5 per each hour logged. Furthermore, members could also invite friends (without any limit!) and would receive an additional \$0.1 for every hour that person was active. In the first quarter of the year 2000 (which coincided with the peak of the bubble) *AllAdvantage.com* paid a total of \$40 million to its members, leading to a loss of \$66 million. It also did not survive the market crash and ceased its operations in that same year. Companies that engaged in similar practices include Spedia, Click-Rebates, Jotter Technologies, Radiofreecash and Adsavers.com (Haacke [2004]).

Some companies also spent huge sums in advertisement and promotional campaigns to catch customers' attention. For instance, *Furniture.com* - a company that sold furniture online - spent \$33.9 million on sales and marketing in 1999, despite generating only \$10.9 million in revenues. *Boo.com* - an internet startup delivering fashion and sports clothing in 18 different countries - spent \$42 million on an advertisement campaign alone. Despite its promotional efforts, the company was always far from meeting its targets: it aimed at creating a website that could handle 100 million web visitors at once; however, it reached no more than 300,000 visits in its final two months. Often regarded as one of the biggest dotcom failures, the company burnt \$185 million of capital over its 18 months of life (it went out

---

[35] See Haacke [2004], p.109

[36] See Haacke [2004], p.91 and Razi, Siddiqui and Tarn [2004]

of business in May 2000).[37]

These business strategies were often justified by a first-mover advantage type of argument - most internet businesses were understood to be natural monopolies, where only one firm could ultimately survive. Hence the search for rapid growth and the "*get big fast*" or "*get large or get lost*" mottos. However, it is important to note that such extreme commercial practices were also incited by financial markets and were possible *"as long as these start-ups received money from venture capitalist funds because they could not be supported by normal business economics*".[38] As already mentioned in section 3.1, the fact that valuation metrics were often focused on revenue targets or market shares created incentives for rapid growth at the expense of profits (Hong and Stein [2003] and Aghion and Stein [2008]). Indeed, venture capitalists and company executives explicitly admitted their strategies were influenced by financial market sentiment. For instance, Michael Moritz - founder of Sequoia Capital, a venture capital firm that was an initial funder of Yahoo! - admitted in an interview that "***The world was rewarding us for raising $250 million and penalizing [us for] raising $25 million. Daring to be great overweighted being cautious***".[39]

In a similar vein, eToys' founder and CEO Toby Lenk admitted that *"It was the whole land-grab mentality.* ***Grow, grow, grow. Grab market share and worry about the rest later.*** *When you're in that cycle, and less capable people are doing I.P.O.'s, it's like an arms race. If you turn down the gun and put it on the table, all you're doing is letting other people pick it up and shoot you. I made the decisions and I take full responsibility. But there were a lot of amazing forces at work.*"[40] Like many other *dotcoms*, eToys would not survive the stock market crash in 2000. Toby Lenk recognizes that the attempt to grow too fast and was one of the main reasons behind the failure of eToys: *"We had the capacity for $500 million in revenue but came to a stop at $200 million. That's hard to survive*".

---

[37] "Boo.com spent fast and died young but its legacy shaped internet retailing" (05/16/2005), retrieved from https://www.theguardian.com/technology/2005/may/16/media.business

Umar [2004, ch. 13]

[38] Haacke [2004], p.109

[39] See Haacke [2004], p.108

[40] "How to Lose $850 Million – And Not Really Care" (06/09/2002), retrieved from http://www.nytimes.com/2002/06/09/magazine/how-to-lose-850-million-and-not-really-care.html

It is therefore interesting to note that as in the British railway *mania* 150 years before, the Nasdaq boom of the late 1990s was also associated with rising competitive pressures in product markets, and with situations of excessive investment and low (or even negative) profit margins that became unsustainable once market sentiment reversed. As argued by Varian: "*the driving force behind the rise and fall of the Nasdaq was simple* ***competition****.* [...] *in 1999 there was no fundamental scarcity of new business models for dot-coms. The result was an* ***intensely competitive environment****, where it has been extremely difficult to make money*."[41]

However, even if lacking market expertise and in many cases investing beyond reasonable levels, many of the new companies posed a competitive threat to incumbents. I next review some examples.

Sun Microsystems and Microsoft One significant example in this category is the one involving SunMicrosystems and Microsoft, which is described in Varian [2003]. Back in 1999 when the *dotcom* bubble was about to reach its peak, Sun Microsystems decided to enter in the office suite market, which was largely dominated by Microsoft Office. It decided to launch a new office suite called StarOffice and to make it available for free. Besides releasing the software at zero price, SunMicrosystems also promised to make its source code, file formats, and protocols free. This move was seen at that time as a clear attack on Microsoft's dominant position in the market: *"Many in the industry view Sun's move as a direct assault on Microsoft's second most lucrative monopoly*".[42] However, Sun would be severely hit by the stock market crash (its stock price plunged from $63.4 in 8/31/2000 to $3.28 in 11/12/2002), which critically compromised the development of StarOffice.

The threats posed by companies such as SunMicrosystems were recognized by Microsoft in its annual reports. For instance, the 2000 report states that "*Rapid change, uncertainty due to new and emerging technologies, and fierce competition characterize the software industry, which means that Microsoft's market position is always at risk.* ***"Open source" software*** *[...]* ***are current examples of the***

---

[41] Hal Varian, "Economic Scene: Comparing Nasdaq and Tulips Unfair to Flowers", The New York Times, 2001/02/08.

[42] Joe Barr, "Is Sun's StarOffice a Microsoft Killer?", 10/08/1999, CNN.com.

rapid pace of change and intensifying competition. [...] Competing operating systems, platforms, and products may gain popularity with customers, computer manufacturers, and developers, reducing Microsoft's future revenue." [Annual Report, 2000, p. 16]

Microsoft also anticipated the necessity to reduce the price of some products*: "The competitive factors described above may require Microsoft to* ***lower product prices to meet competition****, reducing the Company's net income"* [Annual Report, 2000, p. 17]; and to increase R&D expenditure significantly *"It is anticipated that* ***investments in research and development will increase over historical spending levels*** *[...] Significant revenue from these product opportunities may not be achieved for a number of years, if at all."* [Annual Report, 2000, p. 16]

eToys and Toys"R"Us The retail market for toys experienced considerable action in the late 1990s. Several firms such as eToys, Toysmart, Toytime and Red Rocket appeared as online toy retailers, but went bankrupt in the years 2000 and 2001 as stock prices started to decline. The case of eToys was particularly impressive: it was established in 1997, had its IPO in 1999 and in the same year reached a market capitalization of 8 billion dollars! This value was 33% larger than that of the market leader Toys"R"Us, a well-known company, much larger in terms of size and profitability (see Table 2).

Firm	Market Value	Sales	Profits
Toys "R" Us	$ 6 billion	$ 11,200 million	$ 376 million
eToys	$ 8 billion	$ 30 million	$ -28.6 million

Table 2: Sales and profits refer to the fiscal year 1998, whereas market value refers to 1999

Despite of their short existence, the newly founded companies posed a serious competitive threat to Toys"R"Us, which was forced to enter in the online market. After a series of unsuccessful experiences with its own website (toysrus.com), it then started a 10-year partnership with Amazon.com in the year 2000. According to the agreement Toys"R"Us was to be Amazon's exclusive supplier of toys, games and baby products.

The case of eToys is presented by Shiller [2000] as an example of a clear market inefficiency: it reached a market capitalization greater than the purportedly more efficient firm (Toys“R”Us), but went bankrupt immediately after. But even if one agrees that eToys lacked expertise in the toy market and was a relatively inefficient firm, the above conclusion is still unwarranted. It crucially ignores the fact that Toys“R”Us was forced to enter in the online market (and hence to expand) as a strategic response to the entry of eToys and all the other competitors. Seen in this way, the bubble attached to eToys had a positive side effect: it increased competition and forced the market leader to expand.

GE and the “Destroy Your Business” strategy The reaction of Toys“R”Us was common among many large, well-established corporations. One well-known example is the “Destroy Your Business” program launched by GE’s CEO Jack Welch in 1999. Welch asked all GE’s managers to think of possible ways in which Internet startups could challenge their market leaderships in different businesses and to adopt effective strategies to avoid such scenarios. The process was focused on adopting the necessary innovations before a new *dotcom* company appeared and took advantage of such opportunity. For instance, GE Plastics (a specialized supplier of plastics, established in 1973 as a division of GE), decided to enter the online market in 1997. As part of the “Destroy Your Business” program, GE Plastics e-commerce manager Gerry Podesta and his team decide to equip their website with new tools and functionalities. They got inspiration from car manufacturers’ websites, which were developing configuration tools that allowed consumers to customize their cars. A similar scheme was then introduced in the website GE Plastics, allowing potential costumers (such as engineers from manufacturing plants) to design their products online, indicating different materials that could be used, their characteristics and cost.

We can also mention the examples of several other GE divisions, such as GE Transportation, GE Power Systems, GE Appliances or GE Medical Systems. GE Medical Systems - a manufacturer of diagnostic imaging systems such as CAT scanners and mammography equipment - launched an platform called iCenter as part of the “Destroy Your Business” initiative. This was an online system designed to monitor GE customers’ equipment, collect data and provide each customer with information on his relative performance and suggestions on how to improve it. GE Appliances also started using the internet to sell its products. Appliances were traditionally sold through retail stores, but GE feared that such model could be challenged with the emergence of new internet retailers (which could give preference to appliances from alternative brands). It then developed a point-of-sale system placed in traditional retail stores where customers could make online orders. Customers could also schedule an appointment to have the items delivered and installed at their convenience. This way, consumers would benefit from the advice of retailers while the goods would be sent directly into their hands (allowing stores to have reduced inventories). In 2000 GE Appliances reported that 45% of its sales took place on the internet.[43]

The "Destroy Your Business" program adopted by GE provides a nice illustration of the mechanisms at work in the model developed in this paper. As hundreds of internet startups emerged and raised vast amounts of money in the stock market, Welch feared that some of GE's businesses could be challenged if the company did not enter in the online market. This example may be interpreted through the lens of the latent bubble process described in section 1.3: Welch anticipated that if GE did not move, some other companies could easily raise funds and shake their dominant position in specific markets.

1.7 Conclusion

Financial history shows that stock market boom/bust episodes are often an industry phenomenon which can be accompanied by significant changes in the market structure. Motivated by this observation, this paper developed a framework to think about the interactions between asset bubbles and product market competition. At the heart of the model is the idea that asset bubbles may sometimes reduce barriers to entry and force firms to expand, to the ultimate benefit of consumers. An interesting aspect of the theory is that asset bubbles may force (productive) market leaders to expand even when they are attached to potential (unproductive)

---

[43] "E-Business Strategies: Scenario Planning" (07/18/2000), retrieved from https://www.computerworld.com.au/article/84638/e-business_strategies_scenario_planning

competitors. Indeed, if bubbles can only appear attached to the market leaders they will likely have no effect on the market structure and on economic activity. This conclusion suggests that the economic consequences of asset bubbles will crucially depend on its distribution across firm types. It also helps us think about different questions. For instance, how will a large company react to a bubble on its stock prices? Will Apple lower the price of its *iPhones* if investors suddenly become excited about the company and its market value doubles? This paper suggests that it will probably not. Instead, Apple will more likely expand and cut its profit margins in the presence of a generalized boom in which potential competitors (perhaps smaller and less innovative) can also get overvalued! In such case, as barriers to entry decrease, Apple may be forced to expand in order to preserve its market share. Although subject to each reader's own assessment, I believe this view is not totally unreasonable.

The model developed in this paper also gives us a novel perspective on famous stock market overvaluation episodes. For instance, it may explain why British railway companies duplicated some of their own lines during the 1840s *mania* or why large corporations (such as GE) had incentives to quickly adapt their businesses to the internet in the late 1990s. Furthermore, it provides a simple rationale for the low and negative profitability levels reported by internet firms at the peak of the *dotcom* bubble. Rather than the mere realization of a negative technology shock (as argued by Pastor and Veronesi [2009]) this paper suggests that such income losses may have been a rational reaction to an environment characterized by high stock prices. This view seems indeed to receive support from the anecdotal evidence reviewed in section 1.6.

I conclude by pointing some avenues for future research. The first one is about the empirical relationship between stock market overvaluation and competition. The evidence reviewed in section 1.6 suggests that two important bubble episodes were associated with an environment of rising competition. But is there a systematic relationship between stock market overvaluation and measures of product market competition (such as markups or profits)? This is an empirical question, which is left for future work. The model built in this paper suggests that such an empirical analysis will necessarily be subject to important caveats, such as the possibility of latent bubbles or the fact that the distribution of overvaluation across incumbents and followers may change over time. Furthermore, overvaluation is unlikely to be independent of market conditions, which may give rise to several confounding elements. For instance, bubbles may be more likely to appear in times of increased consumer demand or in periods when firms can charge higher markups. This may originate a positive association between overvaluation and profits/markups that does not necessarily invalidate the predictions of the model.

A second issue pertains to the relationship between bubbles and moral hazard. A central tenet of this model is that despite being attached to unproductive firms, asset bubbles can nevertheless improve the workings of good markets and be welfare-improving. One may however argue that bubbles can have the opposite effect: overvaluation can subsidize bad projects or firms, which may impair the workings of both product and financial markets. For instance, in the *dotcom* bubble of the late 1990s we can find many examples of inexperienced firms offering poor services to consumers (such as online retailers failing to make on time deliveries) or even situations of fraud (such as the manipulation of income statements).[44] May asset bubbles exacerbate moral hazard problems and have a negative impact on consumers' or investors' welfare? I believe these are interesting issues that should be explored in future theoretical work.

Finally, by making a connection between the degree of competition in product markets and the interest rate, this paper may also shed light on recent US macroeconomic trends. The last four decades of US history have been characterized by both a steady decline in real interest rates and an increase in market power, evident from an increase in markups (De Loecker and Eeckhout [2017]) and measures of industry concentration (Autor et al. [2017]). Although there may be different forces contributing to the interest rate decline, this model suggests that it can be connected to the increase of market power. I believe that a serious assessment of this hypothesis is an important avenue for future research.

---

[44] For instance, the telecommunications company Worldcom used fraudulent accounting techniques to artificially increase its earnings during the *dotcom* bubble. Examples of fraud could also be found in the South Sea Bubble (Garber [1989]).

1.8 Appendix 1: The Model with Fixed Costs

1.8.1 Industry Equilibrium

Assume that demographics, preferences and the production structure are as described in the baseline model of section 1.2. There are however two differences

1. All entrepreneurs have the same productivity level $\pi_i^j = 1 \quad \forall i, j$
2. Production of intermediate input varieties entails a fixed investment cost c_f (in units of the final good).

Under this modified framework there are no technological differences among types. However, the presence of fixed production costs introduces increasing returns to scale and opens the door for imperfect competition. As before, a monopolist would like to charge

$$p_{i,t+1} = \frac{1}{\rho} \cdot R_{t+1}$$

However, if c_f is sufficiently low, some followers could profitably enter at this price (the conditions on c_f will be determined below). In such a case, the leader must set a limit price so that no individual follower can make a profit upon entry. How is such a limit price determined? Let x be the quantity chosen by the operating firm (time subscripts are omitted for simplicity). If a competitor decides to enter, he will chose $\tilde{x}$ in order to maximize

$$\max_{\tilde{x}} \left[\alpha \cdot K^{\alpha-\rho} \left(x + \tilde{x}\right)^{\rho-1} - R\right] \cdot \tilde{x} - R \cdot c_f$$

which implies a best response function $\tilde{x}^* = f\left(x\right)$ defined by

$$\alpha \cdot (\rho - 1) \cdot K^{\alpha-\rho} \cdot (x + \tilde{x})^{\rho-2} \cdot \tilde{x} + \alpha \cdot K^{\alpha-\rho} \left(x + \tilde{x}\right)^{\rho-1} - R = 0 \qquad (1.41)$$

The leader must produce a quantity such that no follower can enter profitably.

$$\left\{\alpha \cdot K^{\alpha-\rho} \left[x + f\left(x\right)\right]^{\rho-1} - R\right\} \cdot f\left(x\right) - R \cdot c_f = 0 \qquad (1.42)$$

This equation says that, given the output x produced by the leader , if a follower were to enter, he could not make a positive profit.

I will impose parameter restrictions so that $x^M < x$ and the equilibrium quantity is given by the solution of equation (1.42):

$$x = g\left(R\right)$$

Figure 1.15 shows the combinations of (ρ, c_f) that are associated with limit pricing for a given interest rate R, capital stock K and capital share α. The limit pricing region corresponds to low values of ρ.

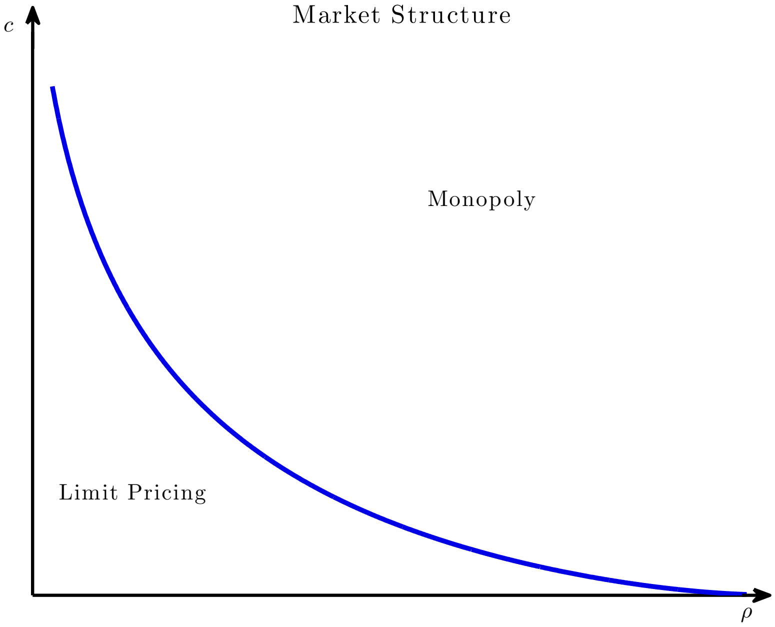


Figure 1.15: Monopoly *versus* Limit Pricing

1.8.2 General Equilibrium

The equilibrium of this economy can be described by the following three equations

$$\alpha \cdot (\rho - 1) \cdot x_{t+1}^{\alpha-\rho} \cdot (x_{t+1} + \tilde{x}_{t+1})^{\rho-2} \cdot \tilde{x}_{t+1} + \alpha \cdot x_{t+1}^{\alpha-\rho} \cdot (x_{t+1} + \tilde{x}_{t+1})^{\rho-1} - R_{t+1} = 0 \tag{1.43}$$

$$\left[\alpha \cdot x_{t+1}^{\alpha-\rho} \cdot (x_{t+1} + \tilde{x}_{t+1})^{\rho-1} - R_{t+1}\right] \cdot \tilde{x}_{t+1} = R_{t+1} \cdot c_f \tag{1.44}$$

$$x_{t+1} = (1 - \alpha) \cdot x_t^{\alpha} - c_f \tag{1.45}$$

The last equations defines the law of motion of this economy. It fully determines the evolution of the capital stock. Due to the presence of a fixed cost, this economy exhibits two steady-states. Only the second one is stable, so the first one will be disregarded.[45] The first two equations can be used to determine the interest rate R_{t+1}.

Under what conditions is the steady-state interest rate lower than one? Figure 1.16 shows the steady-state interest rate for different combinations of (α, c_f).[46] When c_f is sufficiently high (i.e. it lies above the middle curve $R = 1$), the steady-state interest rate is below one. Note that if $c_f = 0$, the condition is $\alpha < 0.5$ as in the benchmark model.

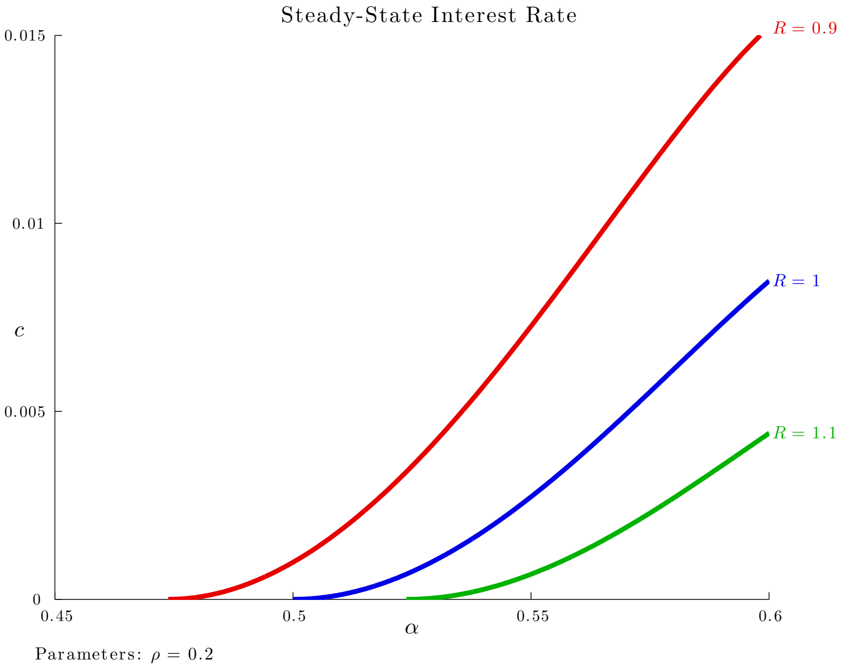


Figure 1.16: Steady-State Interest Rate

Under what conditions is steady-state investment dynamically efficient? Steady-state investment is efficient if

$$\alpha \cdot x^{\alpha-1} > 1$$

---

[45] The stable steady-state is characterized by $\alpha\left(1-\alpha\right)x_{ss}^{\alpha-1} < 1$.

[46] Only the stable steady-state is considered.

i.e. if the marginal product of capital is above its marginal cost of production. Note that we can use equation (1.45) to implicitly define the steady-state capital stock as

$$(1-\alpha)\cdot x^{\alpha-1} = 1 + \frac{c_f}{x}$$

A sufficient (though not necessary) condition for steady-state investment to be efficient is therefore $\alpha > 0.5$. In this case

$$\alpha \cdot x^{\alpha-1} > (1-\alpha)\cdot x^{\alpha-1} = 1 + \frac{c_f}{x} > 1$$

As shown in Figure 1.16 , it is possible to find values of c_f such that $R < 1$ even when $\alpha > 0.5$. Indeed, if the interest rate is sufficiently low, storage can be used in equilibrium; in such case, the economy exhibits underinvestment.

1.8.3 Bubbly Equilibrium

Suppose that entrepreneur can get a firm with size $b \geq 0$. It is easy to see that in this case a bubble has the effect of a reduction in the entry cost. Therefore, it makes entry easier and reduces monopoly profits. As before, equation (1.41) still holds but the no entry condition must be modified to

$$\left[\alpha \cdot K^{\alpha-\rho}\left(x+\tilde{x}\right)^{\rho-1} - R\right]\cdot \tilde{x} - R\cdot c_f + b = 0 \tag{1.46}$$

Equations (1.41) and (1.46) describe the industry equilibrium as a function of R. Naturally, bubbles are expansionary as long as $b \leq R \cdot c_f$. Figure 1.17 shows the equilibrium output and operating profits (of the only producer) as a function of b.[47] As one can see, once it gets too large the bubble may sustain negative operating profits in equilibrium: to deter the entrance of potential competitors, the leader needs to expand his output so much that he ends up having an operating loss. However, such loss is “financed” by the bubble he gets and is optimal: if his output were lower, a competitor would enter and would reduce his profits even further.

---

[47] Operating profits are revenues $p \cdot x$ minus total cost $R \cdot (x + c)$.

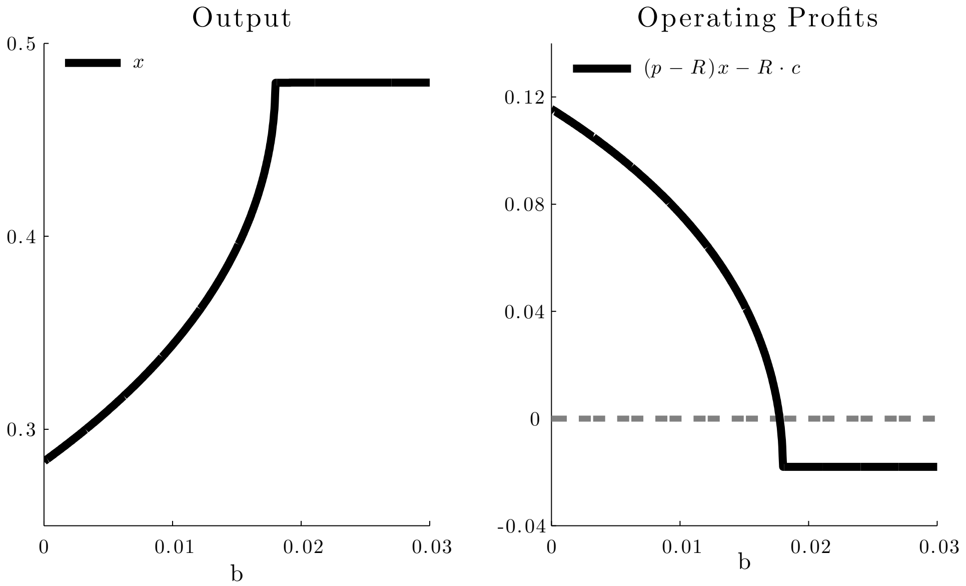


Figure 1.17: Constant Firm-Level Bubble

1.9 Appendix 2: Industry Bubble

Recall the equilibrium conditon

$$\frac{R}{\pi}\cdot x=\alpha\cdot x^{\rho}\cdot K^{\alpha-\rho}+b$$

Define

$$\Theta\left(x\right)=x\frac{R}{\pi}-\alpha\cdot x^{\rho}K^{\alpha-\rho}$$

Θ is increasing in b. Moreover, we have that

$$\Theta^{'}\left(x\right)>0\Leftrightarrow\frac{R}{\pi}-\alpha\cdot\rho\cdot x^{\rho-1}K^{\alpha-\rho}>0\Leftrightarrow\alpha\cdot\rho\cdot x^{\rho-1}K^{\alpha-\rho}<\frac{R}{\pi}$$

$$\Leftrightarrow\pi\cdot\rho\cdot\alpha\cdot x^{\rho-1}K^{\alpha-\rho}<R\Leftrightarrow x>\left(\frac{\pi\cdot\rho\cdot\alpha\cdot K^{\alpha-\rho}}{R}\right)^{\frac{1}{1-\rho}}$$

Finally, note that

$$x\left|_{b=0}\right.=\left(\frac{\pi\cdot\alpha\cdot K^{\alpha-\rho}}{R}\right)^{\frac{1}{1-\rho}}>\left(\frac{\rho\cdot\pi\cdot\alpha\cdot K^{\alpha-\rho}}{R}\right)^{\frac{1}{1-\rho}}$$

Therefore, Θ is increasing in x when $b=0$. Together with the fact that Θ is increasing in b, this implies that $x$is monotonically increasing in b.

1.10 Appendix 3: Constant Bubbles under Financial Frictions

1.10.1 Industry Equilibrium

If the leader lets the followers produce, he must solve the following problem

$$\max_{x^L} (p-R)\cdot x^L + b^L \qquad \text{s.t.} \qquad \begin{aligned} R\cdot\frac{x^F}{\pi} &= \phi\cdot p\cdot x^F + b^F \\ p &= \alpha\cdot K^{\alpha-\rho}\left(x^L+x^F\right)^{\rho-1} \end{aligned}$$

We can combine the two constraints to write

$$F\left(x^L, x^F\right)\ :\ x^F\left[\frac{R}{\pi} - \phi\cdot\alpha\cdot K^{\alpha-\rho}\left(x^L+x^F\right)^{\rho-1}\right] - b^F = 0$$

This equation defines implicitly x^F as a function of x^L: $x^F = f\left(x^L\right)$. The leader will solve the unconstrained maximization problem

$$\max_{x^L}\left\{\alpha\cdot K^{\alpha-\rho}\left[x^L + f\left(x^L\right)\right]^{\rho-1} - R\right\}\cdot x^L + b^L$$

The first order condition requires that

$$\alpha\cdot K^{\alpha-\rho}\left[x^L+f\left(x^L\right)\right]^{\rho-1} - R + x^L\left\{\alpha\cdot K^{\alpha-\rho}\left(\rho-1\right)\left[x^L+f\left(x^L\right)\right]^{\rho-2}\left[1+f^{'}\left(x^L\right)\right]\right\} = 0$$

This equation implicitly defines x^L as a function of b^F through $f\left(x^L\right)$. Note that

$$f^{'}\left(x^L\right) = -\frac{\frac{\partial F}{\partial x^L}}{\frac{\partial F}{\partial x^F}}$$

$$= -\frac{-x^F\left(\rho-1\right)\phi\cdot\alpha\cdot K^{\alpha-\rho}\left(x^L+x^F\right)^{\rho-2}}{\frac{R}{\pi} - \phi\cdot\alpha\cdot K^{\alpha-\rho}\left(x^L+x^F\right)^{\rho-1} - x^F\left(\rho-1\right)\phi\cdot\alpha\cdot K^{\alpha-\rho}\left(x^L+x^F\right)^{\rho-2}}$$

$$= \frac{x^F\left(\rho-1\right)\phi\cdot\alpha\cdot K^{\alpha-\rho}\left(x^L+x^F\right)^{\rho-2}}{\frac{R}{\pi} - \phi\cdot\alpha\cdot K^{\alpha-\rho}\left(x^L+x^F\right)^{\rho-1}\left[1+x^F\left(\rho-1\right)\left(x^L+x^F\right)^{-1}\right]}$$

Let x^{L*} denote the solution to this problem. If the followers produce, the leader's profits will be equal to $\left\{\alpha\cdot K^{\alpha-\rho}\left[x^{L*}+f\left(x^{L*}\right)\right]^{\rho-1} - R\right\}\cdot x^{L*}$. If he instead decides to produce $\bar{x} \equiv \left(\frac{\alpha \cdot \pi}{R}\right)^{\frac{1}{1-\rho}} K^{\frac{\alpha-\rho}{1-\rho}}$, the followers will be out of the market and the leader's profits will be $\left[\alpha \cdot K^{\alpha-\rho} (\bar{x})^{\rho-1} - R\right] \cdot \bar{x}$. Therefore, the leader will accommodate the entry of the followers entrepreneurs only if

$$\left\{\alpha \cdot K^{\alpha-\rho} \left[x^{L*} + f\left(x^{L*}\right)\right]^{\rho-1} - R\right\} \cdot x^{L*} > \left[\alpha \cdot K^{\alpha-\rho} (\bar{x})^{\rho-1} - R\right] \cdot \bar{x}$$

1.10.2 General Equilibrium

In general equilibrium, we have $x^L + x^F = K$.

Equilibrium with accommodation of the followers

As long as b^F is sufficiently small, the leaders prefer to accommodate the entry of the followers. In this case, x^{L*} can be found by plugging $K^* = x^{L*} + f\left(x^{L*}\right)$ in the system of equations above. In this case we have

$$f\left(x^L\right)\left\{\frac{R}{\pi} - \phi \cdot \alpha \cdot \left[x^L + f\left(x^L\right)\right]^{\alpha-1}\right\} - b^F = 0$$

$$\alpha \cdot \left[x^L + f\left(x^L\right)\right]^{\alpha-1} - R + x^L\left\{\alpha \cdot (\rho-1)\left[x^L + f\left(x^L\right)\right]^{\alpha-2}\left[1 + f'\left(x^L\right)\right]\right\} = 0$$

$$f'\left(x^L\right) = \frac{x^F (\rho-1)\,\phi \cdot \alpha \cdot \left(x^L + x^F\right)^{\alpha-2}}{\frac{R}{\pi} - \phi \cdot \alpha \cdot (x^L + x^F)^{\alpha-1}\left[1 + x^F(\rho-1)(x^L + x^F)^{-1}\right]}$$

For this to be the case, no individual leader can have a profitable deviation from this equilibrium. This means that, treating K^* as given, the leaders cannot prefer to produce $\bar{x} \equiv \left(\frac{\alpha \cdot \pi}{R}\right)^{\frac{1}{1-\rho}} (K^*)^{\frac{\alpha-\rho}{1-\rho}}$, for in that case they would drive the followers out of the market. For this to be the case,

$$\left\{\alpha \cdot (K^*)^{\alpha-\rho} \left[x^{L*} + f\left(x^{L*}\right)\right]^{\rho-1} - R\right\} \cdot x^{L*} > \left[\alpha \cdot (K^*)^{\alpha-\rho} (\bar{x})^{\rho-1} - R\right] \cdot \bar{x}$$

If this condition is not satisfied, we have $\bar{x} \equiv \left(\frac{\alpha \cdot \pi}{R}\right)^{\frac{1}{1-\rho}} K^{\frac{\alpha-\rho}{1-\rho}}$ and $K = x^L = x$ implying that $x^L = K = \left(\frac{\alpha \cdot \pi}{R}\right)^{\frac{1}{1-\alpha}}$.

Equilibrium with no accommodation of the followers

If the followers do not produce, then we have $x^L = K = \left(\frac{\alpha\cdot\pi}{R}\right)^{\frac{1}{1-\alpha}}$. For this to be an equilibrium, each leader cannot have an incentive to deviate and accommodate the entry of the followers. Let $\tilde{x}^L$ be the solution to the constrained maximization problem in A.1 when $K = \left(\frac{\alpha\cdot\pi}{R}\right)^{\frac{1}{1-\alpha}}$. For $K = \bar{K} = \left(\frac{\alpha\cdot\pi}{R}\right)^{\frac{1}{1-\alpha}}$ to be an equilibrium,

$$\left\{\alpha\cdot\left(\bar{K}\right)^{\alpha-\rho}\left[\tilde{x}^L + f\left(\tilde{x}^L\right)\right]^{\rho-1} - R\right\}\cdot\tilde{x}^L \leq \left[\alpha\cdot\left(\bar{K}\right)^{\alpha-1} - R\right]\cdot\bar{K}$$

Mixed Equilibrium

If a symmetric equilibrium is not possible, then there will be a *mixed* equilibrium: some industries will accommodate the entry of the followers whereas other will not. In this case, we must observe the following indifference condition

$$\left\{\alpha\cdot K^{\alpha-\rho}\left[\tilde{x}^L + f\left(\tilde{x}^L\right)\right]^{\rho-1} - R\right\}\cdot\tilde{x}^L = R\left[\frac{1}{\pi} - 1\right]\cdot\left(\frac{\alpha\cdot\pi}{R}\right)^{\frac{1}{1-\rho}} K^{\frac{\alpha-\rho}{1-\rho}}$$

where x^L is the output of the leader in industries in which there is accommodation and $\left(\frac{\alpha\cdot\pi}{R}\right)^{\frac{1}{1-\rho}} K^{\frac{\alpha-\rho}{1-\rho}}$ is the output in industries in which there is not. x^L and $f\left(x^L\right)$ are determined by the two equations in A.2.1.

Finally, denote by μ the fraction of industries in which there is accommodation. K must satisfy

$$K = \left\{\mu\cdot\left[x^L + f\left(x^L\right)\right]^{\rho} + (1-\mu)\cdot\left[\left(\frac{\alpha\cdot\pi}{R}\right)^{\frac{1}{1-\rho}} K^{\frac{\alpha-\rho}{1-\rho}}\right]^{\rho}\right\}^{\frac{1}{\rho}}$$

We therefore have a system of four equations in four unknowns that needs to be solved numerically.

Chapter 2

THE REAL SIDE OF STOCK MARKET EXUBERANCE

2.1 Introduction

There is a widespread perception that stock prices experience fluctuations that cannot be accounted for by fundamentals. Examples of such fluctuations include the rise and fall of technology stock prices in the late 1990s (often referred to as the *dotcom bubble*) or of construction and real estate companies in the years prior to 2006 (in what some people called the *US housing bubble*).[1] Even if driven by non-fundamental factors, these fluctuations are nevertheless thought of as having triggered business cycles fluctuations. Indeed, in the two episodes just mentioned, the upturn of stock prices was associated with a protracted expansion, whereas the downturn preceded a recession. In light of some of these events, a recent class of macroeconomic models has been developed to explain how rational asset bubbles can sustain economic expansions.[2]

In spite of substantial evidence that stock prices often depart from fundamen-

---

[1] There are several other examples of stock market booms/busts that seem to be driven by market sentiment, rather than economic fundamentals. Among these we can mention the famous South Sea bubble of 1720, the british railway *mania* of the 1840s or the Japanese stock market bubble in the late 1980s.

[2] These include the models of Fahri and Tirole [2011], Kocherlakota [2009], Martin and Ventura [2011, 2012, 2016], Miao and Wang [2012] and Tang [2017] among others.

tals and of a growing theoretical literature discussing its effects, we still miss a systematic characterization of such non-fundamental fluctuations. In particular, we do not have a clear sense of their magnitude, of how they are related to industry characteristics or whether they correlate with some real variables such as productivity growth or stock market entrants' behavior. The relationship between stock market overvaluation and productivity is of particular relevance. For instance, recent models such as Martin and Ventura [2012] and Miao and Wang [2012] suggest that asset bubbles may bring about an efficient reallocation of resources from unproductive to productive but constrained firms. This view seems however to contrast with anecdotal evidence of some overvaluation episodes, such as the *dotcom* bubble of late 1990s. As it is widely known, this period was associated with the appearance of relatively inefficient firms which, because of insufficient expertise and poorly developed business strategies, could not survive the stock market downturn.[3] Are firms entering in the stock market during financial booms more or less productive? Do they raise funds in the stock market to finance additional investment projects and grow? Or do they simply go public to take advantage of inflated stock prices?

In this paper, I aim at providing a systematic characterization of the non-fundamental component of stock prices at the industry level. To this end, I use the Campbell and Shiller [1988b] methodology to decompose the market value of 41 industries into a fundamental and an overvaluation component, the former reflecting the expected value of future dividend growth minus discount rates.

The goal of this paper is twofold. First, I provide a broad time series description of stock price movements that cannot be explained by fundamentals. Despite abundant anecdotes about particular episodes - such as the *dotcom bubble* of the late 1990s - we still do not have a clear sense about their magnitudes. How large was the late 1990s boom given market expectations about fundamentals? Was it larger or smaller than the boom in the construction sector some years later? More generally, how are non-fundamental stock price fluctuations related to industry

---

[3] Inappropriate business models, lack of market expertise, advertisement overspending and excess capacity are the reasons typically attributed to the poor performance of many *dotcom* entrants. eToys.com, webvan.com or pets.com are some of the most well-known examples. See Haacke [2004] and Razi, Siddiqui and Tarn [2004] for an analysis of some of the biggest *dotcom* failures.

characteristics? In this paper, I show that stock market overvaluation appears to be more volatile in industries with higher profit margins or higher R&D intensity, but seems unrelated to other variables such as labor shares. Consistent with prevailing views, I observe a large deviation between stock prices and fundamentals in a group of technological industries in the late 1990s. However, and contrarily to common perceptions, I find a rather small price-fundamental gap in the construction sector in the years 2004-2006. This suggests that the price of construction firms closely reflected market expectations of future dividends or earnings growth. It further suggests a distinction between *bubbles* attached to the price of *goods* (or revenues/dividends) and *bubbles* attached to the price of *firms*. This is a point that will be discussed in detail below.

The second goal of this paper is to provide additional evidence on the link between stock market overvaluation and some real variables. There is substantial evidence that non-fundamental stock price fluctuations can affect corporate decisions, such as capital accumulation or the dividend policy.[4] However, the empirical literature has to a certain extent ignored other important aspects, such as productivity growth or stock market entrants' characteristics and decisions. These are relevant issues. Recent theoretical models suggest that bubbles can be expansionary if they permit an efficient reallocation of resources from unproductive to productive but constrained firms (Martin and Ventura [2012] and Miao and Wang [2012]). This view seems however at odds with abundant anecdotal evidence of some overvaluation episodes. For instance, the *dotcom* bubble of late 1990s is often regarded as a period in which many inefficient firms went public to take advantage of inflated stock prices.

Corroborating earlier findings, I start by documenting a strong association between industry overvaluation and firm level investment. Young firms are shown to display larger investment sensitivities, particularly with respect to the overvaluation component of industry stock prices (as opposed to the fundamental component). To the extent that young firms are more likely to face credit constraints, these results are consistent with the recent theoretical literature suggesting that as-

---

[4] See for instance Baker, Stein and Wurgler [2003], Campello and Graham [2013], Chirinko and Schaller [2011], Gilchrist, Himmelberg, and Huberman [2005] or Polk and Sapienza [2011].

set bubbles can help firms overcome financial frictions (Martin and Ventura [2011, 2012, 2016], Miao and Wang [2012] and Tang [2017]). Despite exhibiting faster capital accumulation, young firms exhibit lower TFP growth in reaction to industry overvaluation. Furthermore, firms going public in periods of high overvaluation are shown to be on average less productive. This contrasts with the behavior of incumbents, which seem to experience positive TFP growth. These results support the view that industry overvaluation may be associated with the entry of relatively unproductive firms. They are also consistent with the model of Tang [2017], who argues that the emergence of asset bubbles may be associated with a decline in the average productivity of new firms. In his model, this effect can however be efficient, since credit market frictions may force firms to enter below the optimal scale and with inefficiently high productivity levels.

I also show that when stock prices deviate from fundamentals, stock market entrants issue significantly more equity relative to future investment levels, but do not seem to reduce debt issuance. These facts hold even when one looks at cumulative investment levels over a 15-period. Taken together, they support the view that stock market entrants may sometimes overissue equity to take advantage of inflated stock prices. They also suggest that stock market bubbles may occasionally be large enough so as to override firms' credit constraints. This observation raises interesting issues for discussion, such as whether asset bubbles may sometimes be too large.

As far as the main methodology is concerned, some caveats are in order. Calculating the expected present value of dividends (i.e. the fundamental) requires knowledge of (i) the market expectations about future dividends and (ii) the rates used to discount such dividends. Both of these objects are unobservable and some difficulties necessarily arise. In first place, any outside researcher can at most observe a limited subset of all the information that market participants have. This is an important but unavoidable limitation. To address this concern and efficiently use as much information as possible, I follow Campbell and Shiller [1988b] and use the price-dividend ratio as a predictor of future dividends. This methodological aspect has a strong theoretical underpinning. As shown by Campbell and Shiller [1988b], if prices reflect the expected present value of dividends, the price-dividend ratio provides a sufficient statistic for all the information that market participants have about future dividend growth and rates of discount. Even when prices deviate from fundamentals, the price-dividend ratio will still contain relevant information about future dividends.

A second and perhaps more serious hurdle has to do with the determination of discount rates. If stocks are a portfolio of two assets - the fundamental and the bubble - with different expected or *exante* returns, then expected total stock returns will be a composition of the *exante* returns on the two underlying assets. This creates a major identification problem, since fundamental discount rates (i.e. the *exante* rate at which dividends are discounted) may not coincide on average with *expost* or realized price returns. One consequence of this fact is that fundamental discount rates may be unretrievable from observables, unless some assumptions are made. This point is illustrated in a partial equilibrium model in section 2.2 and is later discussed in section 2.3.

The contribution of this paper can be evaluated at different levels. On a theoretical level, I show that when stocks are a portfolio of two assets - the fundamental and the bubble - with different underlying (*exante*) returns, fundamental discount rates may be unretrievable from observables. That is, the same observed sequence of stock prices and dividends can be consistent with different paths for the fundamental and the bubble. This possibility, often ignored within the rational bubbles literature, poses naturally some empirical challenges: for the long-run level of the fundamental (or the bubble) to be obtained, some assumptions will need to be made. A second implication is that stock price returns may be serially correlated even when the returns on the two underlying assets (the fundamental and the bubble) have zero autocorrelation. As discussed below, this fact may provide one possible explanation for the predictability of excess stock returns using price-dividend ratios (Campbell and Shiller [1988b]). On the empirical side, this is the first paper to apply the Campbell and Shiller [1988b] methodology at the industry level and to provide a detailed characterization of the overvaluation measure thus constructed. As already mentioned, the price-dividend ratio is used as a predictor of future dividend growth. This is an important methodological aspect, since prices will (at least in part) reflect market expectations about future dividends. Furthermore, by making use of a formal and precise definition of the fundamental value of equity, the results of this paper can actually be interpreted through the lens of the theory of rational bubbles and can be used to assess the validity of recent models. Second, I provide some new stylized facts on the link between stock market overvaluation and some real variables. By conducting the analysis at the industry level I can look at the impact of overvaluation on the characteristics and behavior of stock market entrants, something that has not been done in the literature.

2.1.1 Related Literature

This paper is related to different strands of the literature. First, there are some studies providing a quantification of the non-fundamental component of famous stock price run-ups. Chirinko and Schaller [2001] studied the behavior of the Japanese stock market in the late 1980s and constructed a measure of its bubble component. To this end, they predict future marginal products of capital by means of a VAR, and use these forecasts to construct the fundamental value of the Japanese capital stock. More recently, Carvalho, Martin and Ventura [2012] made a simple decomposition of the value of US wealth (i.e. the value of the assets held by US households and non-profit organizations) between a fundamental and a bubble component. They showed that US wealth has somehow tracked fundamentals from the 1950s until the mid 1990s. Since then, two major divergences have taken place coinciding with the two episodes already mentioned here: one in the late 1990s (the *dotcom* bubble) and another one in the years 2002-2006 (the *housing* bubble). Contrarily to these studies, I conduct my analysis at the industry level and use the Campbell and Shiller [1988b] methodology to construct fundamentals.

Second, there is a literature studying the real impact of non-fundamental stock market fluctuations. Blanchard, Rhee and Summers [1993] tested the impact of non-fundamental market valuation on aggregate investment, by regressing the US investment rate on market and fundamental Tobin's Q (the latter constructed using a measure of the present value of expected future profits). They showed that once controlling for fundamental Q, market Q had a limited role in explaining US investment. At the micro level, Gilchrist, Himmelberg, and Huberman [2005] used an identified panel VAR to show that investment responds to the dispersion of analysts' earnings forecasts; in the model these authors provide, dispersion in investors' beliefs is associated with the appearance of price bubbles. Polk and Sapienza [2011] find a positive relationship between investment and discretionary accruals, which the authors take as a proxy for overpricing. Moreover, some studies also point to a stronger reaction of firms that are likely to be financially constrained. For instance, Baker, Stein and Wurgler [2003] use the Kaplan-Zingales index to rank firms according to their level of equity dependence and show that firms that rely more on internal financing react disproportionately more to changes in their own market to book ratio (or Tobin's Q). Campello and Graham [2013] look at the behavior of non-technological manufacturing firms in the years of the *dotcom* bubble. They showed that constrained firms tended to increase investment and issue more equity in response to market Q, even when controlling for fundamental Q (constructed as a linear projection of market Q on observables).

A potential limitation of all these studies is the lack of a formal distinction between market and fundamental values. One exception is Chirinko and Schaller [2011], who construct a measure of firm-level overvaluation as the difference between observed and fundamental Tobin's Q, the later reflecting the discounted value of expected future marginal products of capital. Contrarily to the majority of these studies, I will make use of a precise definition of fundamentals, which will be estimated with a methodology that has a strong theoretical underpinning. Furthermore, I will conduct the analysis at the industry level, which allows me to study the effects of overvaluation on stock market entry and entrants' behavior and characteristics.

Finally, there is a recent theoretical literature studying the real effects of asset bubbles, in particular how they can sustain economic expansions. This literature has been essentially focused on the role of asset bubbles in the correction of financial frictions, either through the supply of liquidity (Fahri and Tirole [2011] and Miao and Wang [2012]) or through the provision of collateral (Martin and Ventura [2011, 2012, 2016] and Tang [2017]).

Before proceeding, I shall briefly summarize some anecdotal evidence on violations of the present value model of stock prices.

2.1.2 Some Evidence on Stock Market Exuberance

The idea that stock prices experience movements not related to fundamentals (i.e. expectations about future dividends and/or discount factors) is by no means a novelty. Indeed, this was the object of a strand of research that started in mid-1970s, which includes the variance bound tests developed by Shiller [1981] and LeRoy and Porter [1981] and the statistical tests of the present value model pioneered by Campbell and Shiller [1987, 1988a, 1988b]. A common conclusion of this literature was that stock prices exhibited volatility levels that could not be explained by standard present value models.

There is indeed substantial anecdotal evidence corroborating these findings. Froot and Dabora [1999] discuss the example of Royal Dutch Petroleum and Shell Transport. The two companies share their net assets, earnings and dividends in a fixed ratio of 3:2. Despite this fact being widely known and the stocks of both companies being highly liquid, their market values often diverge from the specified ratio, sometimes by large amounts.[5] In a similar vein, Lamont and Thaler [2003] document clear violations of the present value model associated with equity carve-outs in the late 1990s. They studied in depth the case of 3Com (a profitable provider of network systems), which sold 5% of its subsidiary Palm (a computer producer) through an IPO in 2000. As it was documented, the price reached by the shares of Palm was so high that, if one were to subtract the implied value of the remaining 95% of Palm from 3Com, one would find that the non-Palm part of 3Com had a negative value. This fact persisted for some weeks, despite being reported in the press.[6] The *tech* bubble of the late 1990s provides further example of financial *exuberance*. For instance, Cooper, Dimitrov and Raghavendra Rau [2001] showed that firms changing their name to a ".com" name in 1998-1999 earned large abnormal returns. Such effect was observed even among firms that were already pure Internet players (and for which the new name should not

---

[5] Froot and Dabora [1999] show that price deviations from the 3:2 parity can be as large as 35%.

[6] As mentioned by Lamont and Thaler [2003], "3Com announced that, pending an expected approval by the Internal Revenue Service (IRS), it would eventually spin off its remaining shares of Palm to 3Com's shareholders before the end of the year". This fact rules out the possibility that the market attributed a different value to part of Palm in the hands of 3Com.

signal any change in business strategy).[7] Finally, Ofek and Richardson [2002] made simple calculations and showed that the stock market value reached by the internet sector at the peak of the *dotcom bubble* could only be accounted for, on the basis of the discounted value of future earnings, if estimated growth rates were unreasonably high (far above the rates historically observed for the fastest growing firms in the economy) and/or discount rates were absurdly low. As Robert Shiller [2003] concludes, there is indeed "a clear sense that the level of volatility of the overall stock market cannot be well explained with any variant of the efficient markets model in which stock prices are formed by looking at the present discounted value of future returns".[8]

Even if a large body of the economics profession agrees that stock prices sometimes deviate from the present value of dividends, the causes of such departure are not consensual. While Robert Shiller has himself put forth the idea of *irrational exuberance*, other economists like Stephen LeRoy have argued that exuberance does not necessarily conflict with rationality. This last idea, pointing to the notion of rational bubbles, is again supported by some anecdotal evidence. For instance Brunnermeier and Nagel [2004] study the behavior of hedge funds managers during the *dotcom bubble*. They show that hedge funds managers - who are thought of as being sophisticated, rational investors - understood market sentiment, investing heavily in technology stocks during the price run-up, and reducing their holdings before prices actually started collapsing. These findings are confirmed by Griffin et al. [2011], who show that institutional investors such as hedge funds, mutual funds or banks made roughly 2/3 of active technology stock purchases in the price run-up period 1997-2000; furthermore, such investors were found to be net buyers for the *overvalued* internet carve-out analyzed by Lamont

---

[7] Firms adopting a ".com" name earned cumulative abnormal returns of 53% (89%) on the 5-day (61-day) period around the name change announcement date. These effects are particularly large given that previous studies have failed to identify significant abnormal returns associated with name changes.

[8] Some authors have proposed fundamental-based explanations for the *tech* bubble of the late 1990s. Despite not accounting for some of these obvious examples of over or underpricing, nor for the market values reached by the internet sector in particular, Pastor and Veronesi [2009] argue that the level attained by Nasdaq at its peak in March 2000 could be explained on the basis of higher uncertainty.

and Thaler [2003]. Although all this evidence supports the *rational exuberance* hypothesis, it does not preclude market irrationality. As stated by LeRoy [2004], “there is considerable anecdotal evidence [...] in favor of [...] the rational bubble hypothesis, but there is also evidence that points the other way”.[9]

This article is organized in seven sections. Section 2 offers a simple partial-equilibrium description of the stock market. This will guide the empirical approach used in section 3 to construct the non-fundamental component of industry stock prices. Section 4 provides a systematic characterization of this component across industries and years. Section 5 investigates the link between non-fundamental stock market fluctuations and some real variables, such as investment and productivity growth. Section 6 focuses on the behavior and characteristics of stock market entrants. Section 7 concludes.

2.2 A Stylized View of the Stock Market

To clarify some concepts and guide the empirical methodology to be used below, I will present a highly stylized view of the stock market. The purpose of this section is twofold. The first one is to make a precise definition of the fundamental value of the stock market. The second one is to show that when the fundamental and the bubble component of stock prices are discounted at different rates, the exact level of each component may not be retrievable from observable variables (i.e. a same sequence of stock prices and dividends may consistent with infinitely many paths for the fundamental and the bubble).

Firms will be thought of as assets generating an exogenous (and possibly random) sequence of dividends. As a metaphor, it may be useful to think of firms as trees producing some fruit and to view an industry as a collection of identical trees or a forest. The price of a forest may contain two components, with potentially different expected returns: one representing a claim on the stream of dividends to be generated in the future (the *fundamental*) and another one with no intrinsic value but that can still be traded at a positive price (the *overvaluation* or *bubble*

---

[9] There are also clear overvaluation episodes associated with financial securities other than stocks. One such example is the Chinese put warrants bubble described by Xiong and Yu [2011].

component).

Assume time is discrete and indexed by $t = 0, 1, 2, \ldots$. Every period, new trees are born and some old trees die. Let P_t be the time t price of all existing trees and let $\{D_{t+j}\}_{j=0}^{\infty}$ be the aggregate sequence of cash flows or dividends they generate. To see how P_t is determined let us start by considering a hypothetical security that (i) replicates the sequence of dividends generated by this forest and (ii) contains no bubble. Let F_t (which stands for *fundamental*) denote the price of this security and R_t^F the (gross) expected return the market requires to hold it from t to $t+1$. Then, the following difference equation must be observed in equilibrium[10]

$$F_t \cdot R_t^F = E_t \left(D_{t+1} + F_{t+1} \right) \tag{2.1}$$

The required return R_t^F needs to be determined by an asset pricing model.[11] As for now, I will take it as given. Iterating equation (2.1) forward we can write F_t as a function of expected future dividends and required rates of return

$$F_t = E_t \left\{ \sum_{k=1}^{\infty} \frac{D_{t+k}}{\prod_{j=0}^{k-1} R_{t+j}^F} \right\} \tag{2.2}$$

Note that a *transversality* condition was imposed since we are determining the price of a hypothetical asset that contains no bubble, i.e.

$$E_t \left\{ \lim_{k \to \infty} \frac{F_{t+k}}{\prod_{j=0}^{k-1} R_{t+j}^F} \right\} = 0 \tag{2.3}$$

Sometimes it may be convenient to write (2.2) in log-linear form as[12]

$$f_t \approx d_t + \sum_{j=0}^{\infty} \rho^j E_t \left\{ \Delta d_{t+j+1} - r_{t+j}^F \right\} + \frac{c}{1-\rho} \tag{2.4}$$

where $\rho \coloneqq \exp\left(\bar{g} - \bar{r}^F\right)$, with $\bar{g}$ and $\bar{r}^F$ denoting the growth rate of dividends and the fundamental discount rate along a balanced growth path, $\delta \coloneqq \log\left(\frac{1}{\rho} - 1\right)$

---

[10] Following the standard convention, F_t is the ex-dividend fundamental.

[11] Suppose for instance that agents solve a standard utility maximization problem that yields $F_t = E_t \left[SDF_{t+1} \left(D_{t+1} + F_{t+1} \right) \right]$ where the stochastic discount factor satisfies $SDF_{t+1} = \beta \dfrac{u_c(c_{t+1})}{u_c(c_t)}$. In this case, we have that $R_t^F = \dfrac{E_t \left(D_{t+1} + F_{t+1} \right)}{E_t \left[SDF_{t+1} \left(D_{t+1} + F_{t+1} \right) \right]}$.

[12] See Campbell and Shiller [1988b] for a derivation.

and $c := \log\left[1+\exp\left(\delta\right)\right] - \delta\exp\left(\delta\right)\left[1+\exp\left(\delta\right)\right]^{-1}$. Equation is (2.2) says that the price of a claim on the stream of dividends from a certain asset equals the expected discounted value of such payments. The discount factors are given by the required rates of return. Note that (2.2) is the price of a hypothetical asset that replicates the cash flows of a forest and contains no bubble. If the price of a forest contains no bubble, absence of arbitrage opportunities requires that $P_t = F_t$. However, this does not need to be always the case. Suppose there is a bubble or Ponzi game with size B_t attached to the price of an industry. A Ponzi game can best be seen as an asset that despite generating no cash flow (i.e. it has no intrinsic value) can nevertheless be traded in the market in the expectation that its price appreciates in the future. An example of a pure bubble is a stock that pays no dividend and yet has a positive price.

But how is B_t determined? First note that B_t may contain two components: the current value of all Ponzi games already attached to old trees (i.e. firms existing at $t-1$) but also Ponzi games attached to the trees born at time t (which did not exist in the past).[13] Let N_t be the value of all such new pyramid schemes.[14] Denoting by R_t^B the expected return the market requires to hold a bubble from t to $t+1$, we have that

$$B_t \cdot R_t^B = E_t\left(B_{t+1} - N_{t+1}\right) \tag{2.5}$$

We may again iterate equation (2.5) forward to write

$$B_t = E_t\left\{\lim_{k\to\infty}\frac{B_{t+k}}{\prod_{j=0}^{k-1} R_{t+j}^B}\right\} - E_t\left\{\sum_{k=1}^{\infty}\frac{N_{t+k}}{\prod_{j=0}^{k-1} R_{t+j}^B}\right\} \tag{2.6}$$

According to equation (2.6) the value of a bubble can be written as the difference between two terms: the present value of all the Ponzi games attached to the

---

[13] See Martin and Ventura Ventura [2011, 2012, 2016] and Galí [2017] for recent models that feature bubble creation.

[14] Old firms can also initiate or acquire new pyramid schemes. These new pyramid schemes include for instance the bubble component of new pieces of land or of art works that firms purchase. They will also include the costs of any action that firms pursue with the objective of boosting their bubble component, such as adopting new brand (or a ".com" name, in line with the evidence described in Cooper, Dimitrov and Raghavendra Rau [2001]), developing a new product or hiring a new CEO.

industry in the infinite future minus the discounted value of all new Ponzi games that will still be added to the industry's price. We have then set a model for the price of an industry which, as we have seen, may contain two components: the fundamental and the bubble. This setup is quite general, since I have imposed no restrictions on the required expected rates of return R_t^F and R_t^B. Note that, under this view, the expected return on an industry will be a linear combination of the returns on the two different components F_t and B_t

$$R_t^P = \tau_t R_t^F + (1 - \tau_t) R_t^B \tag{2.7}$$

where R_t^P is the expected return on holding the portfolio from t to $t+1$ and $\tau_t := F_t / P_t$.[15] In principle, there are different reasons why R_t^F and R_t^B may not coincide. For instance, in the presence of risk aversion, required returns will typically be higher for assets with greater levels of risk. If bubbles are perceived as a safe store of value we may have $R_t^B < R_t^F$. This could also be the case if preferences, government regulation, the tax scheme or any kind of distortion favors the demand for one of the assets. Alternatively, the two assets may attract different marginal buyers with different outside investment opportunities (and hence different required rates of return). If the marginal buyer of the fundamental faces a more profitable outside option, we may again have $R_t^B < R_t^F$. However, one might argue that treating the fundamental and the bubble as two distinct assets looks rather odd: after all the two are traded as a single security in the stock market. Indeed, when buying a share in a firm or a tree, an investor is entitled the right to receive not only all future dividend payments, but also a participation in the Ponzi game. If however the two assets have different marginal buyers, this situation can be overcome in a simple way: the marginal investor in the Ponzi game holds the tree and sells a contract promising all future dividend payments to the marginal buyer of the fundamental. A divergence between R_t^F and R_t^B is not usually considered. Ignoring it can however lead to a misestimation of fundamentals, as I will illustrate with some examples below.

Deterministic Economy To illustrate some of the points raised before, let us consider a simple version of the model. Suppose that all existing firms are iden-

---

[15] Note that R_t^P satisfies $P_t R_t^P = E_t \left(D_{t+1} + P_{t+1} - N_{t+1} \right)$

tical and pay a deterministic sequence of dividends that grow at a constant rate g. Moreover, assume that the market requires a time-invariant net fundamental return $r^F > g$. In this case, the fundamental is a perpetuity with value

$$F_t = \frac{1+g}{r^F - g} D_t$$

Now suppose that there is also a bubble attached to the price of an industry. Assume that investors require a certain net return r^B and that the value of new Ponzi games being added or created equals a fraction θ of dividends. In this case, the price of a tree is equal to

$$P_t = \underbrace{\frac{1+g}{r^F - g} D_t}_{F_t} + \underbrace{(1+r^B)B_{t-1} + \theta \cdot D_t}_{B_t} \tag{2.8}$$

Note that given the initial condition B_0 , the price-dividend ratio can be written as

$$\frac{P_t}{D_t} = \frac{1+g}{r^F - g} + \left(\frac{1+r^B}{1+g}\right)^t \frac{B_0}{D_0} + \theta \cdot \sum_{s=0}^{t-1} \left(\frac{1+r^B}{1+g}\right)^s$$

Therefore, the price-dividend ratio is explosive if $r^B \geq g$, but otherwise converges to

$$\lim_{t\to\infty} \left.\frac{P_t}{D_t}\right|_{r^B<g} = \frac{1+g}{r^F - g} + \theta \frac{1+g}{g - r^B} \tag{2.9}$$

As the previous equation shows, observing P_t and D_t and knowing g and θ will not be enough to tell the fundamental and the bubble apart. To understand this result, note that there is an infinity of pairs $\left(r^F, r^B\right)$ consistent with equation (2.9)! This simple example illustrates a major identification problem: when the fundamental and the bubble have different required rates of return, such rates cannot be retrieved from observables. A certain sequence of prices and dividends can be consistent with different processes for the fundamental and the bubble: for instance one with a small fundamental (high r^F) and a large bubble (high r^B), and another with a large fundamental (low r^F) and a small bubble (low r^B).

Indeed, suppose that $r^B < g$ and that the price-dividend ratio is at its long-run level. Now imagine that a researcher acknowledges the existence of a bubble component and knows θ, but assumes that $r^F = r^B$. Suppose further that he uses the steady-state return

$$\hat{r}^F \equiv \lim_{t \to \infty} \frac{D_{t+1} + P_{t+1} - N_{t+1}}{P_t} - 1$$

to calculate the ratio

$$\frac{\hat{F}_t}{D_t} \equiv \frac{1+g}{\hat{r}^F - g}$$

By construction of $\hat{r}^F$, the estimated fundamental-dividend ratio satisfies

$$\frac{\hat{F}_t}{D_t} = \frac{1}{1-\theta} \frac{P_t}{D_t}$$

Therefore, by assuming away a divergence between r^B and r^F, the researcher miscalculates the fundamental for any $\theta \neq 0$. Suppose for instance that $0 < \theta < 1$. In this case, by using $\hat{r}^F$ to discount future dividends, the researcher would obtain a fundamental greater than the observed price, implying a negative bubble.[16] Let us now see a stochastic example.

Stochastic Economy without Bubble Crashes In what follows, it will be useful to work with the log-linear approximation given by (2.4). Suppose that log dividend change follows a first order auto-regressive process

$$\Delta d_{t+1} = (1-\phi)\,\bar{g} + \phi \Delta d_t + u_{t+1} \tag{2.10}$$

where $\bar{g}$ is the long-run dividend growth rate, $\phi \in (-1, 1)$ and $u_{t+1} \sim N\left(0, \sigma_u^2\right)$ is a white noise shock. For simplicity, I will assume that the required net return on the fundamental is constant and equal to r^F.[17] In this world, the only source of risk affecting fundamentals comes from the dividend process (2.10).[18] The

---

[16] If on the other hand $\theta > 1$, the resulting value for the bubble is positive, but the estimated fundamental is actually negative. This possibility must be ruled out, since projects with negative fundamental values cannot be taken in equilibrium.

[17] r^F could be for instance the sum of a risk-free rate $\underline{r}$ and a constant risk premium ω.

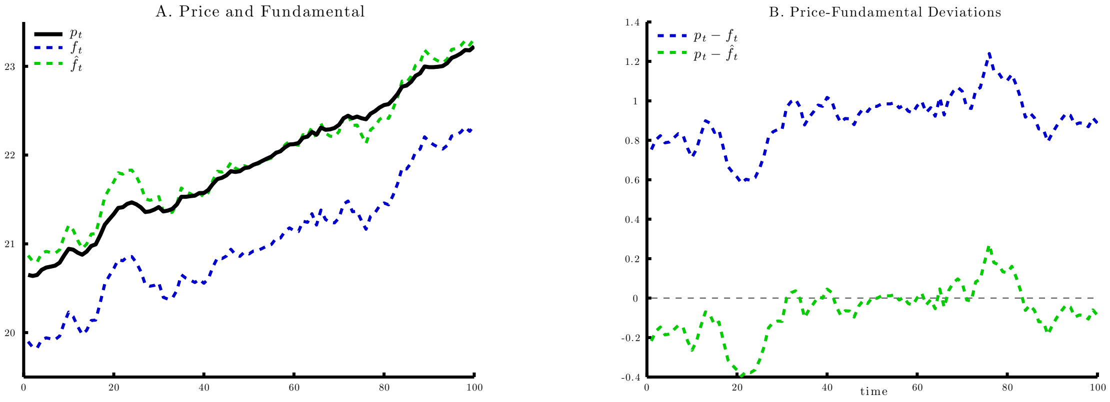
[18] The expost return on the fundamental $\xi^F_{t+1} \equiv \log\left[\exp\left(d_{t+1}\right) + \exp\left(f_{t+1}\right)\right] - f_t$ will typically differ from r^F. This happens through the realization of d_{t+1}, which provides a direct return on the fundamental but also contains information about future dividend growth.

fundamental can be written as

$$f_t = d_t + \frac{\phi}{1-\rho\phi}\left(\Delta d_t - \bar{g}\right) + \frac{\bar{g} - r^F + c}{1-\rho} \qquad (2.11)$$

where $\rho = \exp\left(\bar{g} - r^F\right)$, $\delta = \log\left(\frac{1}{\rho} - 1\right)$ and $c = \log\left[1 + \exp\left(\delta\right)\right] - \frac{\delta \exp(\delta)}{1+\exp(\delta)}$.

As in the previous example, I will assume that the value of new bubbles being added to the industry is equal to a fraction θ of current dividends.[19] Net bubble returns are assumed to be deterministic and equal to $r^B < \bar{g}$. Panel A of Figure 1 shows a simulation of this economy over 100 periods and for a particular parameter configuration.[20] The full black line shows the simulated price p_t and the dashed blue line shows the fundamental f_t . Panel B show the price-fundamental deviation $p_t - f_t$ (dashed blue line). Differences between the return on old bubbles r^B and the fundamental growth rate induce fluctuations in the price-fundamental deviation. In the simulation shown, the relative size of the bubble fluctuates between 60% of the fundamental around period $t = 20$ to more than 120% percent of the fundamental around period $t = 75$.


A. Price and Fundamental

B. Price-Fundamental Deviations

Parameters: $\bar{g} = 0.03$, $\phi = 0.6$, $\sigma_u = 0.03$, $\theta = 0.2$, $r^F = 0.08$ and $r^B = 0.02$

Parameters: $\bar{g} = 0.03$, $\phi = 0.6$, $\sigma_u = 0.03$, $\theta = 0.2$, $r^F = 0.08$ and $r^B = 0.02$

Figure 2.1: Price, Fundamental and Price-Fundamental Deviation

Consider now a researcher who knows that dividend growth is governed by (2.10) and that there is a constant fundamental discount rate. Can he infer the

---

[19] θ can be easily made a stochastic variable.

[20] The simulation is run over a 10,000 periods. The window displayed corresponds to period 501-600.

model parameters by observing the realized price and dividends? The parameters of the process in (2.10) can be easily retrieved by fitting a first order autoregressive model to the observed time series of dividends. More problematic is the estimation of the required fundamental discount rate r^F. Suppose that the researcher knows θ buy wrongly assumes away a divergence between r^F and r^B and estimates f_t using the average price return

$$\hat{r} = \frac{1}{T-1} \sum_{t=1}^{T-1} \left\{ \log \left[(1-\theta) \exp \left(d_{t+1} \right) + \exp \left(p_{t+1} \right) \right] - p_t \right\}$$

Though r^F enters nonlinearly in (2.11), one can show that f_t decreases in r^F (for a particular dividend path). Therefore, if $r^B > r^F$ the researcher overestimates r^F and the fundamental will be undervalued. If on the other hand we have $r^B < r^F$ the researcher underestimates r^F and the fundamental will be overvalued. The dashed green line in Panel A shows the fundamental estimated with the procedure described above. Given the particular set of parameters chosen, the researcher overestimates the fundamental.[21] There are periods in which the estimated fundamental lies above the observed price, implying a negative price-fundamental deviation (see Panel B of Figure 1).

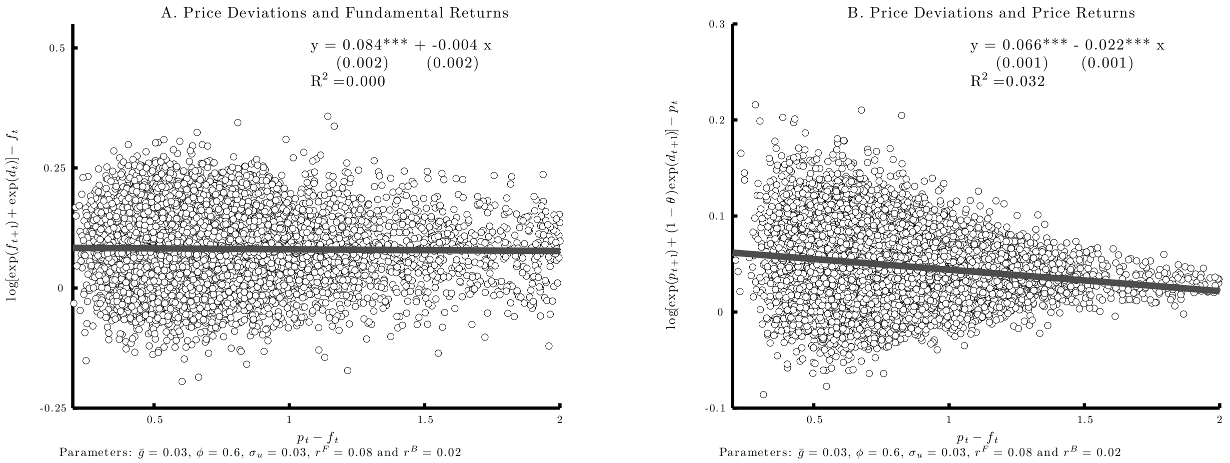
The divergence between r^F and r^B in this stochastic example has other implications. A well-established fact in the finance literature is the ability of price-dividend ratios to predict future stock returns (Campbell and Shiller [1988b]). This fact arises naturally in the context of this model: a high price-fundamental deviation (or a high price-dividend ratio) today indicates a larger share of the bubble and that future price returns will approach r^B. Figure 2 shows the correlation between fundamental returns (Panel A) and total price returns (Panel B) against the lagged price-fundamental deviation for a simulation of this economy over 10,000 periods. As one can see, the price-fundamental deviation is uncorrelated with future fundamental returns. However, there is a strong statistical association between overvaluation and future price returns. Given that $r^B < r^F$, the price-fundamental ratio is negatively correlated with future price returns.[22] The

---

[21] The researches estimates $\hat{r} = 0.054$, whereas the fundamental discount rate is equal to $r^F = 0.08$.

[22] The particular parameters chosen imply a correlation between lagged price-fundamental de-

divergence between the required fundamental and bubble returns was taken as given. However, it could be for instance justified on the grounds of risk aversion. Given that dividends are risky and bubbles are assumed to grow at a deterministic rate, investors may require a higher fundamental rate of return. In such case, when bubbles become relatively larger, stocks become less risky and hence the total required price return decreases. It is interesting to note that it is risk aversion that makes the price-fundamental deviation a predictor of future stock returns, though there are no changes in risk premia. In this example, fluctuations in the price-fundamental ratio are exclusively driven by shocks to dividend growth (or by realized fundamental returns).


A. Price Deviations and Fundamental Returns

Parameters: $\bar{g} = 0.03$, $\phi = 0.6$, $\sigma_u = 0.03$, $r^F = 0.08$ and $r^B = 0.02$

B. Price Deviations and Price Returns

Parameters: $\bar{g} = 0.03$, $\phi = 0.6$, $\sigma_u = 0.03$, $r^F = 0.08$ and $r^B = 0.02$

Figure 2.2: Price-Fundamental Deviations and Future Returns

2.3 Stock Prices and Fundamentals at the Industry Level

In this section I describe the data and methodology used to construct a measure of stock market overvaluation at the industry level.

---

viations and one period fundamental returns of 0.0064 and between one period price returns of -0.2381.

2.3.1 Data and Industry Classification

I will use an unbalanced panel constructed from the COMPUSTAT and CRSP databases for the period 1975-2013. Agricultural companies (two-digit NAICS 11), utilities (two-digit NAICS 22), financial corporations (two-digit NAICS 52), companies listed outside the US and with a maximum book value under \$10 million are excluded. Observations that are likely to be associated with large mergers/acquisitions are also deleted.[23] Apart from this selection criteria, the panel contains all firm-year observations with nonmissing data on industry classification, sales, earnings, assets, dividends and investment (from COMPUSTAT) and stock prices and common shares outstanding (from CRSP). As mentioned, the analysis will be carried at the industry-aggregated level.

Firms are grouped into 41 different industries. Most industries are defined at the 3-digit NAICS level, but there are some exceptions. Following standard practices and to ensure industries are somehow similar in terms of number of observations, some 3-digit cells are merged (for instance, Apparel (NAICS 315) and Leather and Allied Products (NAICS 316) are merged into a single industry group) whereas others are divided (for instance, within Chemicals (NAICS 325), Pharmaceuticals (NAICS 3254) is singled out). Table 1 of Appendix B provides a complete description of the industry classification used, as well as some statistics (number of firms and aggregate market capitalization by industry).

2.3.2 Measuring Fundamentals

In this section I describe the methodology I use to measure the fundamental component of industry stock prices. The basic approach builds on Campbell and Shiller [1988b] and resorts to calculating the right-hand side of equation (2.4). Naturally, such equation applies for each industry. I will start by imposing some structure on the required fundamental return. In what follows, I will assume that it has two components: a risk-free rate $\underline{r}_t$ plus an industry risk premium $\omega_{i,t}$. The risk premium can be further decomposed into a common time-varying part ω_t plus

---

[23] I exclude firms with sales footnote code of "AB" (indicates more than 50 percent of reported sales are due to a merger or an acquisition) and firms that report acquisitions (COMPUSTAT item #129) representing more than 50% of total assets (COMPUSTAT item #6).

a time-invariant and industry-specific component σ_i

$$\omega_{i,t} = \omega_t + \sigma_i$$

The treatment of the industry-specific component σ_i will be discussed in Subsection 2.3.2. As for the common time-varying part I will assume that it can be well approximated by the (expected) excess market return over the one-year risk free rate, i.e.

$$\omega_t = E_t\left(r_t^M\right) - \underline{r}_t$$

r_t^M represents the return on a stock market index to be chosen below.[24] This simple, reduced-form specification has the advantage that it can be easily incorporated in the VAR methodology of Campbell and Shiller [1988b]. Indeed, given these assumptions, equation (2.4) can be rewritten as

$$f_{i,t} = d_{i,t} + \sum_{j=0}^{\infty} \rho_i^j E_t \left\{\Delta d_{i,t+j+1} - r_{t+j}^M\right\} + \frac{c_i - \sigma_i}{1 - \rho_i} \tag{2.12}$$

The right-hand side of this equation can be computed once we propose a process for $\Delta d_{i,t+1} - r_t^M$ and given assumptions about σ_i.[25] As illustrated in the examples of the previous section, if the fundamental and the bubble have different required rates of return, σ_i may not be retrieved from observable data and some assumptions need be made. As regards the process for $\Delta d_{i,t+1} - r_t^M$, a parsimonious candidate would be a simple AR(1). However, following Campbell and Shiller [1988b] I will consider the following VAR

$$\underbrace{\begin{bmatrix} \Delta d_{i,t+1} - r_t^M \\ p_{i,t+1} - d_{i,t+1} \\ \psi_{i,t+1}^5 \end{bmatrix}}_{\mathbf{z_{i,t+1}}} = \underbrace{\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}}_{\mathbf{A}} \underbrace{\begin{bmatrix} \Delta d_{i,t} - r_{t-1}^M \\ p_{i,t} - d_{i,t} \\ \psi_{i,t}^5 \end{bmatrix}}_{\mathbf{z_{i,t}}} + \underbrace{\begin{bmatrix} u_{i,t+1}^1 \\ u_{i,t+1}^2 \\ u_{i,t+1}^3 \end{bmatrix}}_{\mathbf{u_{i,t+1}}} \tag{2.13}$$

where $p_{i,t}$ is the log of real price at the end of year t and $\psi_{i,t}^5 := \left(\mathrm{op}_{i,t} + \cdots + \mathrm{op}_{i,t-4}\right)/5 - p_{i,t}$ is a 5-year moving average of log operating profits minus current log price. In

---

[24] In what follows, any return r_t denotes the return on an asset from the end of year t to the end of year $t+1$.

[25] Recall that ρ_i and c_i are functions of the steady-state dividend growth and fundamental discount rates.

this VAR all variables should be read in deviation from their industry-specific mean (hence the exclusion of a constant term). Here, (log) dividend growth minus the market return is allowed to depend on the lagged price-dividend ratio and a moving average of past operating profits. The inclusion of the price-dividend ratio is important: this is likely to provide a statistical summary of the information the market has about future dividends. Indeed, absent price bubbles or any form of mispricing, $p_{i,t} = f_{i,t}$ and p_{it} is itself the present discounted value of future dividends. As Campbell and Shiller [1988b] show this hypothesis can be tested as a restriction on the parameters of the VAR. However, as they show for the S&P composite index during 1900-1987, it is likely that $p_{i,t} \neq f_{i,t}$ (which could be due to the presence of a bubble component). Even if this case is true, the price-dividend ratio can nevertheless provide relevant information about future dividends and hence it is included. The variable $\psi^5_{i,t}$ is a modification of the variable constructed in Campbell and Shiller [1988b] who use a 30-year moving average of (log) earnings. Contrarily to Campbell and Shiller [1988b], I cannot use a 30-year window due to my smaller sample size.[26] Furthermore, operating profits (to be defined below) are preferred to net earnings simply because net earnings happen to be occasionally negative in some industries (and hence logarithms cannot be applied).

Equation (2.13) defines a pooled VAR: it imposes the same matrix of coefficients A across industries. This option is preferred over an industry specific VAR for two main reasons. First, an industry specific VAR requires estimating 9 parameters with only 34 data points, making the results very sensitive to outliers and not robust to the exclusion of special years.[27] A pooled VAR, on the other hand, yields coefficient estimates that are quite stable across subperiods (i.e. when special events such as the *dotcom* period 1998-2002 or the crisis years 2008-2009 are excluded). Second, the pooled and the industry-specific VAR yield very similar

---

[26] The results would however be identical if different time windows were used (for instance 3 or 10 years).

[27] In most industries, mainly in the late part of the sample, there are years where price-dividend ratios or dividend growth rates are a bit extreme. These observations heavily condition the results and pose one additional challenge as forecasts in the early part of the sample would depend on observations that had not yet happened.

results for the vast majority of the industries (as discussed in the section 2.3.4). All the regressions estimates shown in sections 2.4 to 2.6 use the fundamental measure estimated with the pooled VAR. The results with the industry-specific VAR are identical for all variables considered, and are made available upon request.

Variable Definitions

All industry variables defined in this section are aggregated from firm level data. A correction factor is applied to adjust for the listing/delisting of firms (see Appendix 2.9.1 for details). $p_{i,t}$ is the log of total market capitalization, defined as the end-of-year stock price times common shares outstanding (data from CRSP). $d_{i,t}$ is the log of total dividends, defined as the sum of common dividends (COMPUSTAT item #21) and net stock repurchases (COMPUSTAT item #115 - item #108 - Δ item #56). Aggregate net stock repurchases are set to zero when negative.[28] $\text{op}_{i,t}$ represents the log of operating profits. I define operating profits as sales (COMPUSTAT item # 12) minus the cost of goods sold (COMPUSTAT item # 41) and depreciation (COMPUSTAT item # 14). All variables are deflated by the Consumer Price Index (obtained from the Bureau of Labor Statistics).

Finally, r_t^M will be chosen as the real return on the S&P composite index used by Campbell and Shiller [1988b], which is a commonly used benchmark.[29] The average yearly return from 1950 to 2013 is $\bar{r}^M = 0.071$.[30]

VAR Results

Table 4 shows the results of the VAR estimation. Both the price-dividend ratio $p_{i,t} - d_{i,t}$ and the moving average of operating profits $\psi_{i,t}^5$ happen to be strong predictors of discount-adjusted dividend growth $\Delta d_{i,t+1} - r_t^M$. As mentioned earlier, $p_{i,t} - d_{i,t}$ will contain relevant information about future dividend growth. Current

---

[28] Even if individual firms are allowed to pay a negative dividend (i.e. they issue new stock in net terms), this is precluded at the industry-aggregated level. This is done to ensure that aggregate dividends are always strictly positive so that a growth rate is well defined. In a robustness exercise, in which I assume perfect foresight and therefore do not need to forecast dividend growth, I will not impose this zero lower bound on net stock repurchases.

[29] Consistent with the notation used, r_t^M is the return from the end t to the end of $t+1$.

[30] The average return in the period 1980-2013 it is slightly higher and equal to 0.080.

dividend growth $\Delta d_{i,t} - r_{t-1}^M$ also predicts future dividend growth $\Delta d_{i,t+1} - r_t^M$. However, the two seem to be negatively correlated, i.e. fast dividend growth in the past indicates slower dividend growth in the future. Indeed, when we look at $\Delta d_{i,t}$ alone, we find that 34 industries (out of 41) have a negative first order autocorrelation.[31] This contrasts with the results that would be obtained on economy-aggregated data, where dividend growth exhibits a positive first order autocorrelation.[32]

The Long Run Fundamental Rate of Discount

The VAR estimated above can be used to forecast $\left\{\Delta d_{i,t+j} - r_{t+j}^M\right\}_{j=0}^{\infty}$. To compute the right hand side of equation (2.12), I still need to make assumptions about ρ_i and σ_i. Recall that $\rho_i := \exp\left(\bar{g}_i - \bar{r}_i{}^F\right)$ where $\bar{g}_i$ is the long-run growth rate of dividends and $\bar{r}_i{}^F = \bar{r}^M + \sigma_i$ is the long-run fundamental discount rate. I will choose $\bar{g}_i$ as the average dividend growth rate within the period.[33] Taking $\bar{r}^M = 0.071$ (the average return on the S&P composite index), I only need to make assumptions about σ_i . As illustrated with the examples of the previous section, if bubbles and the fundamental have different required rates of returns, σ_i may be not retrieved from average realized price returns. Note however that this constant essentially pins down the level of the fundamental, but has a minor impact on its time patterns. This is illustrated in Figure 2.3 for the Semiconductors industry. The upper panel shows the observed price and estimated fundamental for two possible values for σ_i. The first one is obtained by minimizing the average square of the price-fundamental gap $p_{i,t} - f_{i,t}$, which yields $\sigma_i = 0.042$ for this industry (blue line). The second one uses the theoretical argument that if overvaluation is driven by rational bubbles, it cannot be negative. In such case,

---

[31] The average first order autocorrelation equal to -0.231 and the median is equal to -0.232.

[32] In section 2.4, I will make some comparisons between my industry results and the ones that would be obtained by replicating the Campbell and Shiller [1988b] methodology on the S&P composite index.

[33] There is substantial dispersion in terms of average dividend growth rates. They range from -0.071 in Textile Mills to 0.121 in Media (see Table 3). In a robustness exercise not reported in this paper, I impose a common growth rate $\bar{g}_i = 0.04$ across all industries. The price-fundamental deviations obtained in this alternative exercise exhibited very identical patterns.

the fundamental can be pinned down by imposing a non-negative lower bound on the price-fundamental deviation, for instance $\min\{p_{i,t} - f_{i,t}\} = 0$. This yields $\sigma_i = 0.051$ for this industry (green line). As one can see, the two fundamental values have obviously different levels, but identical time patterns. This can be seen in the bottom panel of Figure 2.3, which plots the two price-fundamental deviations $p_{i-t} - f_{i,t}$. As one can see with this example, σ_i will shift the price-fundamental gap up or down, but it has minor impact on its time variation. It is precisely such (within-industry) time variation what will be explored in the rest of this paper.

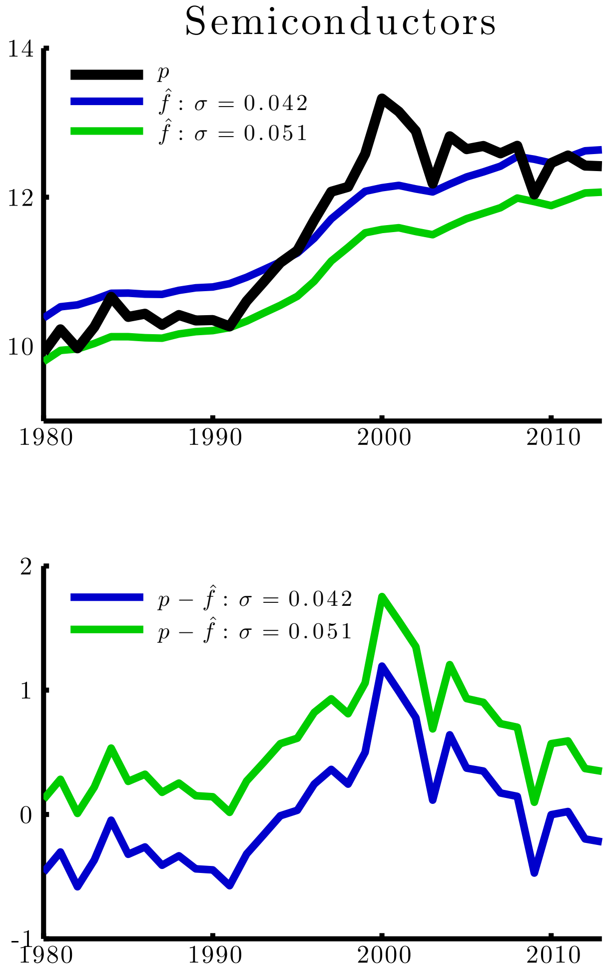


Figure 2.3: Semiconductors

Table 2 shows the fundamental long-run discount rates $\bar{r}_i^F = \bar{r}^M + \sigma_i$ for all

41 industries, calculated with the two alternative procedures just considered. Column 3 shows the fundamental discount rates obtained by minimizing the average square of the price-fundamental gap. Column 4 shows the discount rates obtained by imposing a zero lower bound on the price-fundamental deviations. Two points are worth noting. First, the first procedure yields negative fundamental long-run discount rates for two industries (Textile Mills and Non Metallic Mineral Products). This happens because these sectors have quite negative average dividend growth over the period (column 2). Second, and not surprisingly, the second procedure yields higher fundamental discount rates for all industries.

Although a theoretical argument can be made to preclude a negative price-fundamental deviation, the theory of rational bubbles offers no guidance as to what the minimum deviation should be. Indeed, nothing guarantees that the minimum deviation observed in a particular industry is 0 and not 0.2 . Therefore, the exact level of the price-fundamental gaps will not be identified. This means that I will not be able to compare overvaluation across industries, but rather how it evolves within a given industry. I will then use the first procedure and choose the level of the fundamental that minimizes the average square of the price-fundamental gap. This guarantees that all industries have an average price-fundamental gap close to zero. Then, $p_{i,t} - f_{i,t}$ can be taken as the price-fundamental gap in deviation from the industry-specific average, which facilitates comparison across industries.[34]

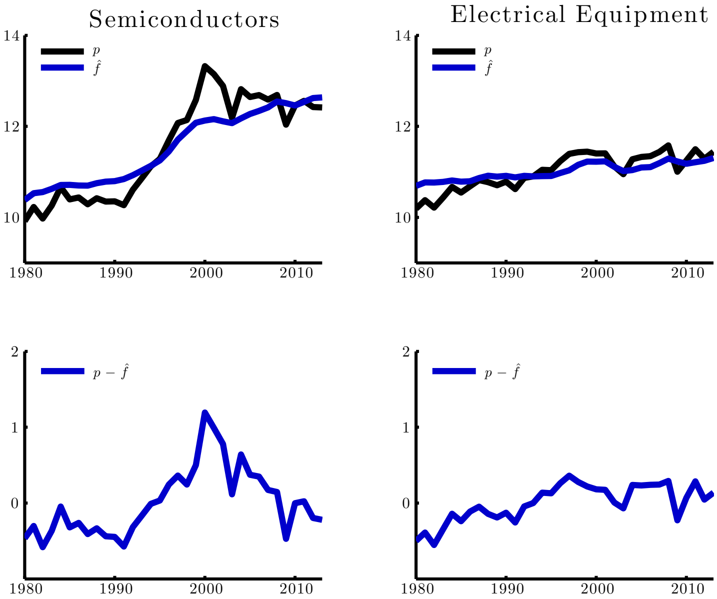
2.3.3 A First Look at the Price-Fundamental Deviations

Before making a systematic description of the results, it may be useful to compare the evolution of prices and fundamentals in different industries. Figure 2.4 compares two manufacturing industries: Semiconductors and Electrical Equipment. The price of the Electrical Equipment industry is characterized by virtually no growth during the sample period, and appears more volatile than the estimated fundamental. Semiconductors, on the other hand, are characterized by a growing price until the late part of the sample. Again, the observed price appears to be substantially more volatile than the estimated fundamental and there seems to

---

[34] I will refer to $p_{i,t} - f_{i,t}$ as the price-fundamental deviation, price-fundamental gap, price-fundamental ratio or simply overvaluation interchangeably.

be a big departure in the late 1990s (in the period of the *dotcom* bubble). As we can see from the bottom panels of the two industries, the price-fundamental deviations observed in Electrical Equipment are mild as compared to the ones exhibited by Semiconductors. Recall that the exact level of the fundamental (and hence of the price-fundamental deviations) is not identified. Therefore we cannot assess the average relative importance of the fundamental and non-fundamental components. Nevertheless, such relative magnitudes seem to exhibit fluctuations that are different across industries.


Semiconductors

Electrical Equipment

Figure 2.4: Semiconductors *versus* Electrical Equipment

Figures 2.15 and 2.16 in appendix D show the evolution of the price-fundamental deviations for all industries obtained with the pooled VAR described above (dark line). Some patterns can be detected and will be examined in more detail below. For instance, the largest deviations seem to be concentrated in 1999 and 2000 in a bunch of technological industries, both in manufacturing (Pharmaceuticals, Computer and Peripheral Equipment, Communications Equipment, Semiconductors) and services (Software Publishers, Media, Telecommunications, Information). Some industries experience large and volatile price deviations (Telecommunications Equipment, Software Publishers), whereas in others there is substantially less action (Paper Products Manufacturing, Chemicals or Transportation).

2.3.4 Some Robustness Checks

Robustness Check I: How to Measure Cash Flows?

In the preceding exposition, cash flows are constructed as the sum of ordinary dividends and net stock repurchases. However, it is often argued that earnings (rather than dividends) is the right measure of cash flows that investors should discount. The argument is based on a simple reasoning: earnings may not be entirely distributed as dividends, as shareholders may find it optimal to invest part of them in the firm. However, as Miller and Modigliani [1961] and Shiller [1981] discuss, this reasoning suffers from a double counting problem, since part of the earnings generated today are due to investments made in the past.[35]

However, there may be situations in which measures of earnings or of earnings potential may be more appropriate than actual dividends. For instance, in the first years of their lives, firms often do not pay dividends. This makes it difficult (if not impossible) to forecast changes in dividends. The same is true for relatively new, fast growing sectors (such as the internet industry in the 1990s). To address some of these concerns, I alternatively measure cash flows by operating profits (i.e. before subtracting interest payments and taxes).[36] Operating profits are preferred to actual earnings as new industries may exhibit low or even negative earnings, that do not reflect their growing potential. Given this assumption, we have a modified version of equation (2.12)[37]

$$f_{i,t} = \text{op}_{i,t} + \sum_{j=0}^{\infty} \rho_i^j E_t \left\{ \Delta \text{op}_{i,t+j+1} - r_{t+j}^M \right\} + \frac{c_i - \sigma_i}{1 - \rho_i} \tag{2.14}$$

---

[35] Think for instance of a firm whose earnings grow at a steady rate g, which is attained because certain a fraction of earnings (say 30%) are reinvested in every period. As it is clear from this example, only 70% of earnings will be available to stockholders. If however they (wrongly) discount the totality of earnings these will be counted twice: part of the earnings generated tomorrow are due to the investment made today.

[36] As before, I define operating profits as sales (COMPUSTAT item # 12) minus the cost of goods sold (COMPUSTAT item # 41) and depreciation (COMPUSTAT item # 14).

[37] Note that one could alternatively assume that only a fraction ν_i of operating profits can be distributed as a dividend to shareholders. In such case, the previous equation would need to be

The VAR in equation (2.13) needs to be adjusted: the first variable will be replaced by log operating profit growth (minus the return on the S&P composite index) and the second by the log price to operating profit ratio. The VAR results can be found on Table 5. Contrarily to dividend growth, operating profits exhibit positive first order autocorrelation at the industry level. To obtain the fundamental, I choose σ_i so as to minimize the average square price-fundamental deviation. Figure 2.5 compares the resulting deviation against the ones obtained before (i.e. with dividends). As it can be seen, the two are very highly correlated (correlation is 0.962) and there do not seem to be systematic differences since the observations are spread on both sides of the 45 degree line.

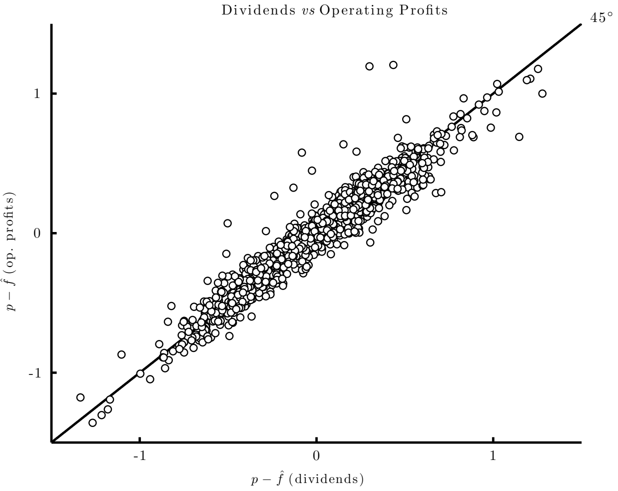


Figure 2.5: Dividends or Operating Profits?

Robustness Check II: Pooled or Industry VAR?

Ideally, an independent VAR should have been run on each industry. This has not been chosen as the preferred option given the limited sample size (with only 34

---

modified as

$$f_{i,t} = \nu_i + \text{op}_{i,t} + \sum_{j=0}^{\infty} \rho_i^j E_t \left\{ \Delta\text{op}_{i,t+j+1} - r_{t+j}^M \right\} + \frac{c_i - \sigma_i}{1 - \rho_i}$$

As it is clear, ν_i is a mere constant that affects the level of $f_{i,t}$. A similar approach, though in a different context, is followed by Ofek and Richardson [2002] in their analysis of the internet industry.

observations per industry). However, if I were to run an industry-specific VAR, I would find very similar results. Figure 2.6 compares the price-fundamental deviations obtained with an industry VAR against the ones obtained before with the pooled VAR. As it can be seen, the two are highly correlated (correlation is 0.839) and again there seem to be no systematic differences. I also compare a pooled and an industry-specific VAR if operating profits were instead used as a measure of cash flows (see Figure 2.7). The two measures again exhibit a strong correlation.

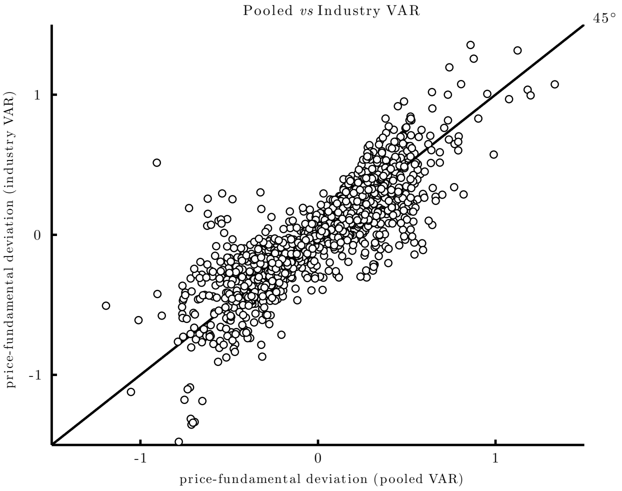


Figure 2.6: Pooled or Industry VAR?

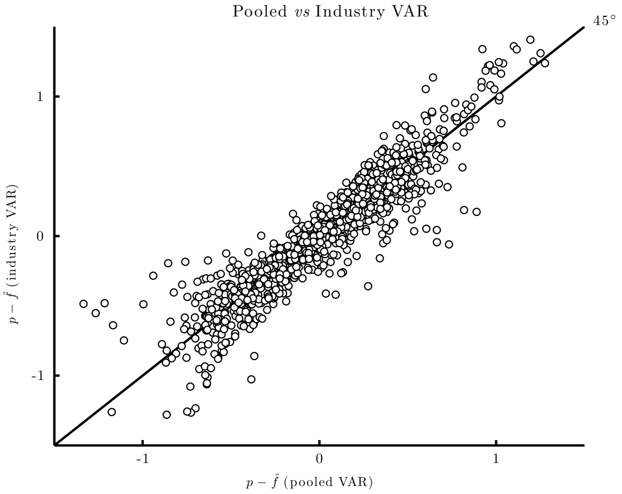


Figure 2.7: Pooled or Industry VAR?

Figures 2.15 and 2.16 (appendix D) that the two procedures yield remarkably identical price-fundamental deviations for the vast majority of the industries.

Robustness Check III: VAR or Perfect Foresight?

To conclude, I follow Shiller [2000] and Carvalho, Martin and Ventura [2012] and make a different set of assumptions about the way expectations are formed. I assume that within sample dividends are known and that out-of-sample dividends are expected to grow at a constant rate g_i. Furthermore, I assume there is a constant industry-specific discount rate r_i. Given these assumptions, a log linear approximation is not needed and the fundamental can be written exactly as

$$F_{i,t} = \sum_{j=t}^{2012} \left(\frac{D_{i,j+1}}{(1+r_i)^{j+1-t}} \right) + \frac{1}{(1+r_i)^{2013+1-t}} \frac{(1+g_i)\, D_{i,2013}}{r_i - g_i} \tag{2.15}$$

As before g_i will be taken to be the average growth rate in the period g_i , whereas r_i is chosen to minimize the average square price-fundamental deviation. Figure 2.8 compares the price-fundamental deviations obtained with this simple methodology with the ones obtained with a pooled VAR. As one can see, the overvaluation ratios obtained with the two procedures are also highly correlated (correlation is 0.676) and differences between the two do not seem to exhibit any systematic pattern.

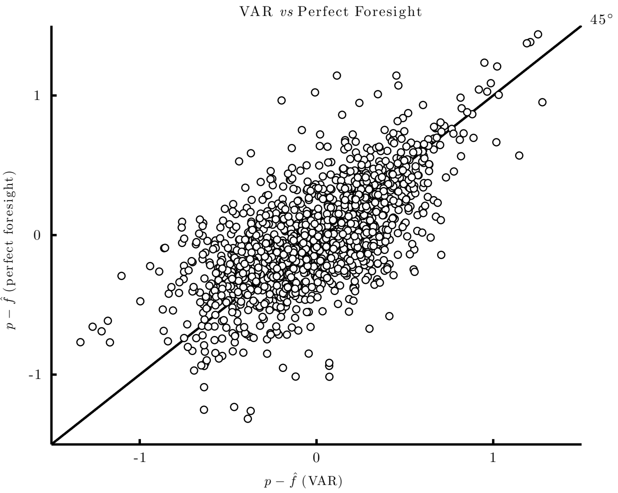


Figure 2.8: VAR or Perfect Foresight?

Figures 2.17 and 2.18 show the price-fundamental deviations obtained with this alternative procedure for all 41 industries.

2.4 Characterizing Price-Fundamental Deviations

This section provides a description of the evolution of price-fundamental ratios over time and shows some basic correlations at the industry level.

2.4.1 The Evolution of Price-Fundamental Deviations

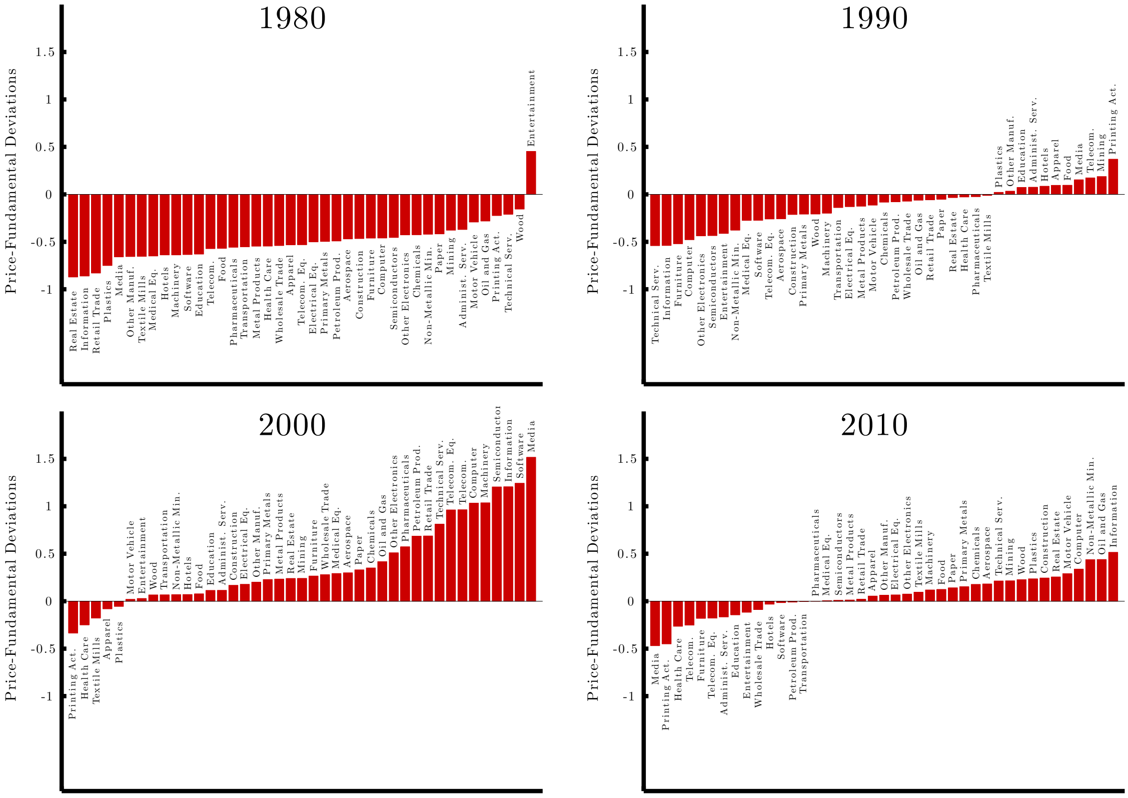


Figure 2.9: Distribution of the Price-Fundamental Deviation

Figure 2.9 shows a snapshot of all price-fundamental deviations at four different points in time: 1980, 1990, 2000 and 2010. Recall that the assumptions about the long run discount rate imply a zero average price-fundamental gap (for each industry). All the values can therefore be seen in deviation from the industry-specific mean. A comparison between the four panels shows that overvaluation was particularly prevalent in the year 2000, with the vast majority of the industries exhibiting price-fundamental deviations above the mean. As it is clear, the boom was particularly concentrated in high-technology industries (Media, Semiconductors, Software, Information, ...). It is however interesting to note that in a period of a general boom, some industries exhibited overvaluation ratios below their means (Textile Mills, Health Care, Apparel, Printing Activities, ...). Figure 2.10 provides a more complete description of the evolution of overvaluation over time. The blue line in Figure 2.10 shows the evolution of an aggregate price-fundamental deviation defined as[38]

$$p_{\text{agg}} - \hat{f}_{\text{agg}} \equiv \log\left[\sum_i \exp\left(p_i\right)\right] - \log\left[\sum_i \exp\left(\hat{f}_i\right)\right]$$

As one can see, stock prices grew faster than fundamentals until the late 1990s and there seems to be essentially two phases. Between 1981 and 1995 there is a relatively slow divergence between prices and fundamentals (the deviation increases somewhere between 0.4 and 0.6 in a 15 year period). However, this divergence clearly accelerates in the late part of the 1990s: the aggregate price-fundamental deviation increases by 0.6 in the 5 year period that goes from the beginning of 1996 to the beginning of the year 2000, essentially the same variation as in the preceding 15 years. The maximum price-fundamental deviation was achieved in the beginning of the year 2000. Since then, the overvaluation ratio exhibited a downward trend. The decline in the price-fundamental-deviation was particularly accentuated in the period 2000-2002 and later in 2008. This picture suggests that overvaluation was particularly important in the late 1990s and early 2000s, the period that is was to be known as the *dotcom* bubble.

Figure 2.10 also includes the price-fundamental deviation of the S&P composite index obtained by replicating the VAR of Campbell and Shiller [1988b]. The methodology used in this paper builds on the work of Campbell and Shiller

---

[38] The exact level of the industry fundamental values naturally matters. However, a very similar time pattern emerges if the long-run fundamental discount rates are obtained by imposing a zero lower bound on the price-fundamental deviations.

[1988b], but there are some differences: (i) data on the S&P composite index exists since 1871, which makes it possible to use more than one century of data in the VAR, (ii) a 30-year moving average of past earnings is included (rather than a 5-year moving average as I do), (iii) the fundamental is constructed under the assumption of a constant discount rate.[39] Moreover, the COMPUSTAT panel that I construct may not coincide with the set of firms in the S&P composite index. However, and despite these differences, the two aggregate price-fundamental deviations evolve in a very similar way. The price-fundamental deviations obtained by running a VAR on the S&P composite index are a bit more volatile the aggregate deviations that I construct.[40] However, this alternative approach also implies a fast divergence between stock prices and fundamentals in the second half of the 1990s, the maximum deviation being achieved still at the beginning of the year 2000.

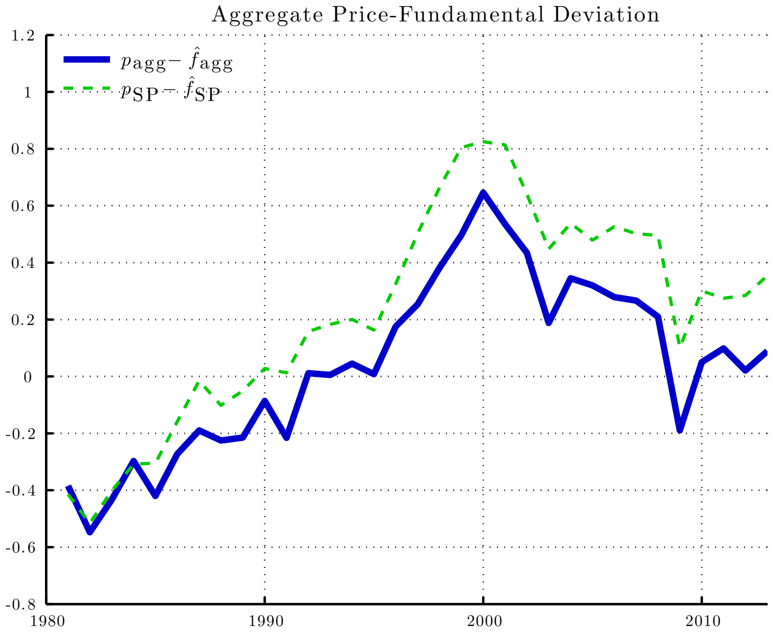


Figure 2.10: Aggregate Price-Fundamental Deviations

---

[39] The long run discount-factor was set to $\bar{\rho} = 0.925$.

[40] This may be explained by the facts that Campbell and Shiller [1988b] use a 30-year moving average of past earnings in the VAR (which evolves more smoothly than a 5-year moving average) and assume a constant fundamental discount rate.

The *Dotcom* and the Real Estate Bubbles

The late 1990s boom was particularly concentrated in a group of technological industries, as the third panel of Figure 2.9 suggests. We have already examined in detail one of these industries (Semiconductors). To complement the analysis, Figure 2.11 shows the price, fundamental and price-fundamental gap for other three high-tech industries: Publishing Industries (that includes software developers), Media and Telecommunications. Consistent with the patterns observed in Figure 2.3 for Semiconductors, these three industries display prices that are substantially more volatile than fundamentals and a significant price-fundamental deviation in 1999/2000 (particularly relevant in Publishing Industries and Media).

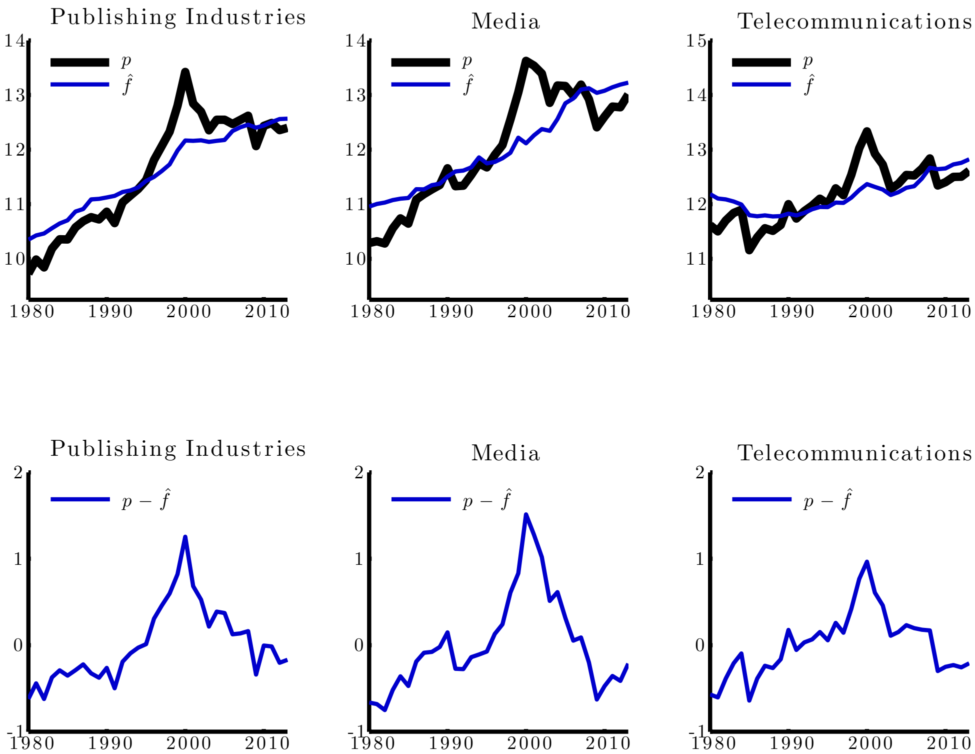


Figure 2.11: The *Dotcom* Bubble

The US housing bubble (2004-2006) is a major event in the recent macroeconomic history, often seen as one of the culprits of the great recession. One may therefore ask if the methodology adopted here confirms the existence of a significant bubble in the housing industries, i.e. whether there is a significant departure of stock prices from fundamentals. Figure 2.12 shows the price, fundamental and price-fundamental gap for two of these industries: Construction and Real Estate. Looking at Construction, stock prices experienced fast growth in the period 2004-2006, to decline in the subsequent three years. In 2009, the price of construction firms was actually below the level reached in 2004. This pattern seems a priori consistent with a bubble view. However, it is interesting to note that the estimated fundamental exhibits a strikingly similar behavior. Although the two peaks do not exactly coincide (the price reaches its maximum in the beginning of 2006, whereas the fundamental grows until the beginning of 2007), the price and estimated fundamental evolve in tandem, so that there is no significant change in the price-fundamental deviation. This seems to contradict the idea of a housing bubble. Such conclusion is however unwarranted. Indeed, this example helps clarify the concept of stock market bubble that was introduced in the partial equilibrium model of section 2.2. Recall that the fundamental was defined as a discounted sum of future dividend growth. Note however that dividend growth may itself be generated by the appearance of a bubble. It is easiest to understand this fact taking once more the example of the construction industry: if houses become overvalued, the earnings and dividends generated by construction firms are likely to increase, which boosts their market value but also their fundamental. Indeed, the VAR used in section 2.3 includes a moving average of past profits, which was shown to be a strong predictor of dividend growth and increased significantly in the years of the house price boom.[41] Therefore, the methodology used in this paper is not meant to capture the appearance of bubbles in output prices, but rather bubbles that appear attached to stock prices. This distinction may be important on theoretical grounds. It is therefore worth emphasizing that the results shown in this paper pertain to stock market or financial overvaluation and not to bubbles in output prices. The price-fundamental deviation of the Real Estate industry does not exhibit any remarkable pattern. This industry includes firms that provide housing services; as it is known, rents did not increase significantly during the years of the

---

[41] It is also interesting to note that the results are different when perfect foresight is assumed. As shown in the fourth panel of Figure 2.17, if within sample dividends are assumed to be known, a noticeable price-fundamental deviation is observed between 2004 and 2006.

housing bubble (see Shiller [2007]).

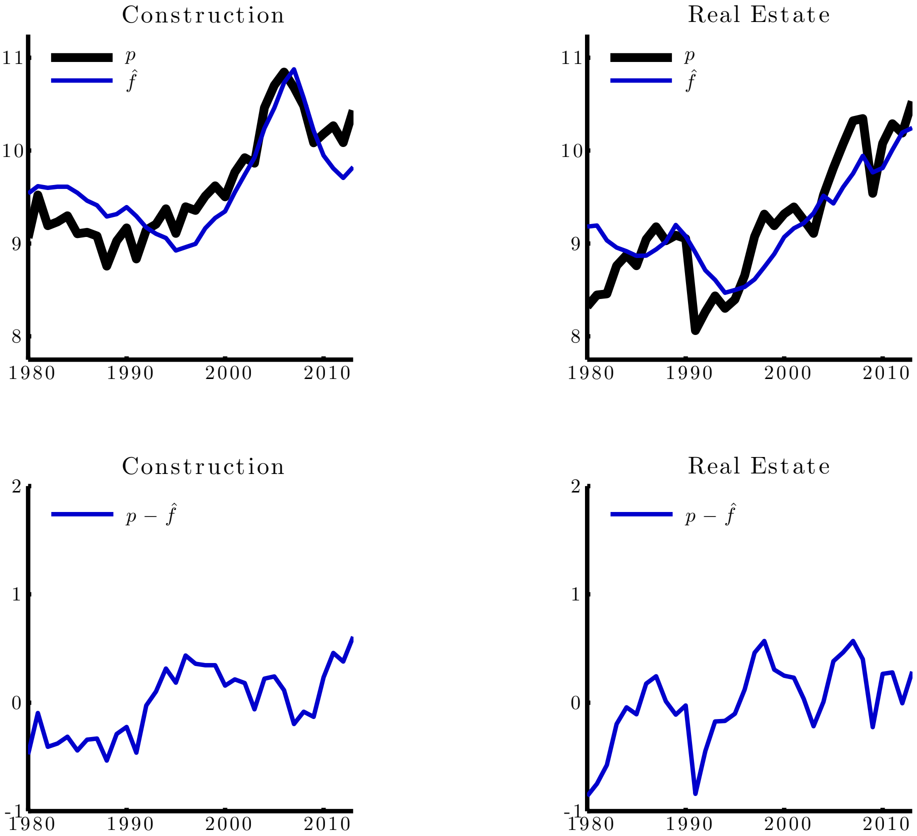


Figure 2.12: The Housing Bubble

2.4.2 Stock Price Fluctuations and Industry Characteristics

Is the volatility of price-fundamental deviations related to some industry characteristics? For instance, are labor intensive industries more prone to have larger non-fundamental stock price fluctuations? In this subsection, I look at the correlation between the variability of price-fundamental ratios and three industry characteristics: labor share, profit margin and R&D intensity. *labor share* is the average employment compensation share of value added, taken from the NIPA tables for the US economy.[42] The two other variables are constructed with industry-

---

[42] Data is available for the period 1988-2013 through the BEA at https://www.bea.gov/industry/gdpbyind_data.htm

aggregated data from COMPUSTAT. *profit margin* is the industry average ratio of gross profits to total revenues in the period 1981-2013.[43] *R&D intensity* is the industry average ratio of R&D expenditure to total revenues for the period 1981-2013.[44] I measure the variability of price-fundamental ratios with two alternative measures: its standard deviation (computed for each industry) and the difference between the maximum and the minimum ratio (again computed for each industry). Figure 2.13 shows how the variability of price-fundamental ratios correlates with industry characteristics. The left panels show the standard deviation of the price-fundamental ratios against the three industry characteristics considered. As one can see, labor intensive industries tend to experience more volatile non-fundamental fluctuations; the correlation is however small and not statistically different from zero. The two other panels suggest that industries with higher profit margins or higher ratios of R&D intensity tend to exhibit more volatile overvaluation. In the case of profit margins, the correlation appears particularly strong (the coefficient of adjustment is equal to 15.4%). These results are confirmed in the right panels of Figure 2.13, that display the correlations for the maximum-minimum deviations. All in all, there seems to be evidence that non-fundamental stock price fluctuations are related to some industry characteristics: industries with higher average profitability or that are somehow more innovative (higher average R&D intensity) exhibit more volatile price-fundamental ratios.[45] These correlations may be useful in guiding theoretical models.

---

[43] Gross profits correspond to earnings before interest, taxes and depreciation (item #21 - item #41 - item #189) and revenues are given by sales (item #12).

[44] R&D expenditure is given by COMPUSTAT item #46.

[45] Instead of constructing *profit margin* and *R&D intensity* with industry aggregated data, one could use averages from the corresponding firm level ratios. The results are identical.

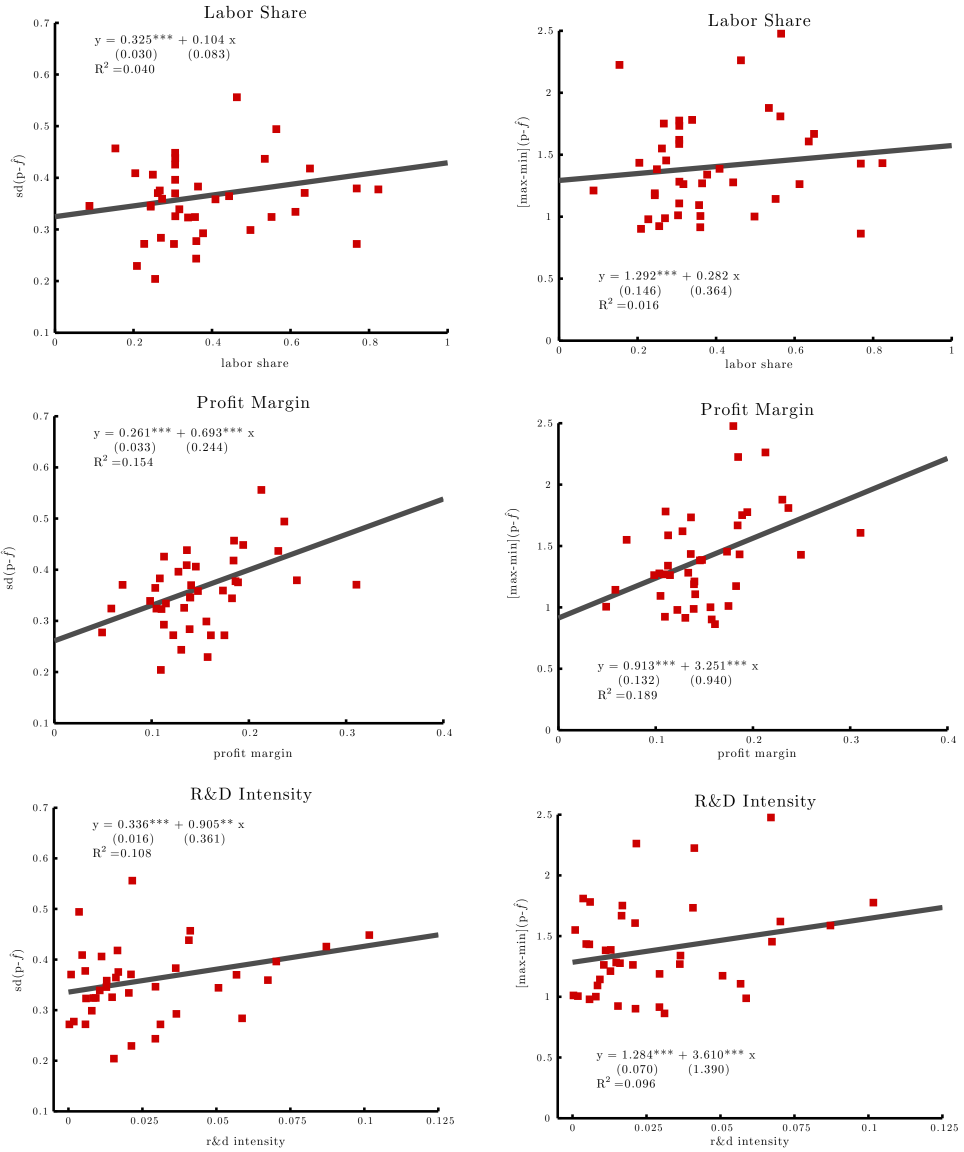


Figure 2.13: Price-Fundamental Volatility and Industry Characteristics

2.4.3 Some Correlations

Finally, I will show how the price-fundamental deviation correlates with some other variables. Figure 2.14 plots the price-fundamental deviations against four variables: the industry market to book ratio (or Tobin's Q), the fundamental growth rate, the industry investment and employment growth rates. All variables represent industry aggregates and are in deviation from the industry specific mean (hence the exclusion of a constant). Tobin's Q is the market value of equity (common shares outstanding times stock price from CRSP) plus assets minus the book value of equity (COMPUSTAT item #60 + item #74), all divided by assets. Investment rate is the ratio of total capital expenditure (COMPUSTAT item #128) to the beginning of the year capital stock.[46] Finally, employment growth is the growth rate of the number of employees (COMPUSTAT item #29).[47]

As we can see, price-fundamental deviations exhibit a strong positive correlation with each one of the four variables considered. Not surprisingly, high stock prices (with respect to fundamentals), are associated with high market-to-book ratios. This correlation is shown because market-to-book ratios are often used as a measure of stock price non-fundamental variation. As we can see in the second panel, large price-fundamental deviations tend to occur in periods of high fundamental growth. This suggests that periods of high overvaluation tend to coincide with fast dividend or fundamental growth. This is after all not surprising, since in the VAR results of section 2.3 price-dividend ratios (which are obviously correlated with price-fundamental deviations) were shown to be a strong predictor of future dividend growth. Note that this correlation may be open to different interpretations. It is for instance consistent with the recent theoretical literature showing that asset bubbles can help constrained firms increase investment and hence income/fundamentals. This finding is also consistent with a different view, under which overvaluation can itself be a function of fundamentals. For instance, Froot and Obstfeld [1991] constructed a simple asset pricing model with rational bubbles that are a function of dividends/fundamentals. These two hypotheses are not contradictory and additional evidence will be needed to assess their validity. The last two bottom indeed suggest a strong positive correlation between overvaluation and investment and employment growth, which is consistent with the first view. These correlations will be examined in detail in the next section.

---

[46] The capital stock is constructed with a perpetual inventory method described in the appendix.

[47] When computing the investment and employment growth rates in a given year I only include all active firms in that year, so that the numerator and denominator all calculate with the same set of firms.

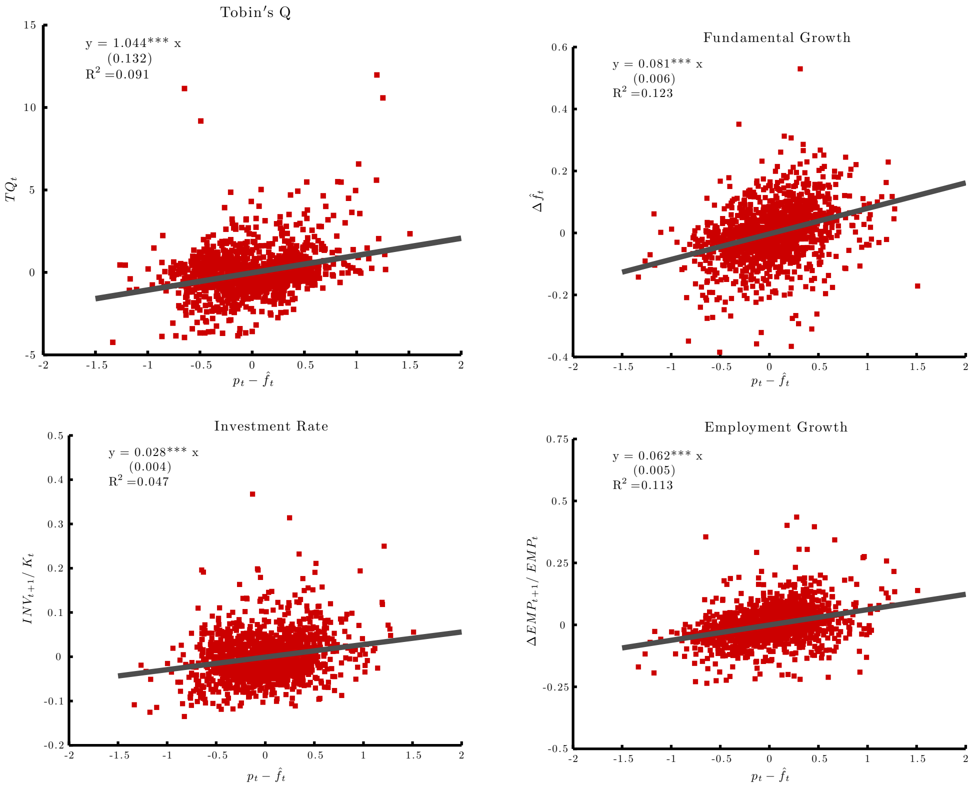


Figure 2.14: Price-Fundamental Deviation and other Industry Variables

2.5 The Real Side of Stock Market Exuberance

How do non-fundamental stock price fluctuations correlate with real variables? Are they associated with greater or lower levels of investment? Do firms change their borrowing or dividend policy? These questions are the object of analysis of this section. I should however emphasize that the direction of causation will not be identified and all patterns described here should be interpreted as simple correlations. These correlations can nevertheless give an important characterization of financial cycles and may help us assess the validity of different models.

2.5.1 Stock Prices and Entry

I start this section by documenting a strong positive association between industry overvaluation and stock market entry. For every firm in the period of analysis

(1981-2013), I take the year of the first observation in CRSP-COMPUSTAT as the year of its IPO.[48] Denoting by $\mathrm{N}_{j,t}$ the number of firms active in year t and industry j and by $\mathrm{N}^{\text{new}}_{j,t}$ be number of entrants in the same industry and year, I run the following regression

$$\left(\mathrm{N}^{\text{new}}_{j,t}/\mathrm{N}_{j,t-1}\right) = \alpha\ \Delta\mathrm{FUND}_{j,t-1} + \beta\ \mathrm{PDEV}_{j,t-1}\ + \lambda_j\ + \eta_t\quad + u_{j,t} \tag{2.16}$$

where $\Delta\mathrm{FUND}_{j,t} \equiv f_{j,t} - f_{j,t-1}$ is the growth rate of the fundamental in industry j and year t and $\mathrm{PDEV}_{j,t-1} \equiv p_{j,t} - f_{j,t}$ is the price-fundamental deviation. λ_j and η_t capture industry and year specific effects. Lagged fundamental growth is included to control for changes in fundamentals that can be correlated with overvaluation. Equation (2.17) is estimated with simple OLS and the standard errors are clustered at the industry level. The results are shown in Table 6, which reports the estimates of α and β and the standardized beta coefficients in square brackets. The first column considers a restricted version of the model where $\Delta\mathrm{FUND}_{j,t}$ is excluded. The estimate of β is positive and highly significant: when prices deviate from fundamentals in a particular industry, more firms tend to go public. The economic magnitude is also relevant: a one-standard deviation increase in the price-fundamental deviation $\mathrm{PDEV}_{j,t-1}$ predicts a 0.012 increase in the firm entry rate, which represents 17.5% of its standard deviation. Adding lagged fundamental growth does not alter the point estimate of β , as we can see in the second column of Table 8. Lagged fundamental growth is also positively and significantly correlated with stock market entry. This variable seems however relatively less important, as its standardized beta coefficients display lower magnitudes.

Columns 3 to 5 provide some additional robustness exercises. As discussed in section 2.4, the methodology used in this paper should capture bubbles attached to the price of firms and not to the price of goods. These two types of bubbles, despite being different theoretical objects, may however be correlated in practice. To ensure that the correlations are driven by firm price bubbles, I exclude six industries whose output prices may occasionally contain a bubble component: Oil and Gas Extraction (1), Mining (2), Construction (3), Petroleum and Coal Products (10), Primary Metals (15) and Real Estate (36). The results are shown in column 3: the estimate of β barely changes and remains highly significant. As a second robustness exercise, I exclude the *dotcom* years 1998 to 2002, which included the largest

---

[48] See Baker, Stein and Wurgler [2003].

price-fundamental deviations and can be therefore be seen as a special period. The results are shown in column 4. As one can see, the estimate of β does not seem to be affected by *dotcom* years 1998 to 2002. The results described here confirm some the findings in earlier studies, such as Pagano, Panetta and Zingales [1998].

2.5.2 Industry Overvaluation and Investment

I will now study the relationship between stock market overvaluation and investment, which is central in financial economics. The analysis will be conducted at the firm level. Following Baker, Stein and Wurgler [2003], I consider the following regression model

$$(\mathrm{I}_{i,t}/\mathrm{K}_{i,t-1}) = \alpha \ (\mathrm{CF}_{i,t}/\mathrm{A}_{i,t-1}) + \beta \ \mathrm{PDEV}^{\mathrm{IND}}_{i,t-1} \ + \lambda_i \ + \eta_t \quad + u_{i,t} \tag{2.17}$$

where $\mathrm{I}_{i,t}/\mathrm{K}_{i,t-1}$ is the investment rate of firm i in year t, defined as the ratio of capital expenditures (COMPUSTAT item #128) to the beginning-of-period capital stock. The capital stock is constructed with a perpetual inventory method (see appendix 2.9.2 for details). $\mathrm{CF}_{i,t}/\mathrm{A}_{i,t-1}$ is the ratio of income before depreciation (COMPUSTAT item #18 + item #14) , to the beginning of period total assets (COMPUSTAT item #6). $\mathrm{PDEV}^{\mathrm{IND}}_{i,t-1}$ is the industry price-fundamental deviation at the end of period $t-1$, described in section 2.3. γ_i and η_t capture firm and year specific effects. All nominal variables are deflated by the CPI and firm level ratios are Windsorized at the 1% and 99% percentiles. Equation (2.17) is estimated with simple OLS and the standard errors are clustered at the industry level. I first estimate equation (2.17) without including cash-flow over assets. The results are shown in the first column of Table 7, which report the estimates of β and the standardized beta coefficients in square brackets. As one can see, there is a very significant correlation between lagged industry-level price-fundamental deviation and firm-level investment rate. This correlation survives the inclusion of standard controls (cash flow over assets in this case), as we can see in column 2. The economic magnitudes are also relevant. Taking the results from column 2, a one standard deviation increase in the price-fundamental deviation predicts a 0.0361 increase in the investment rate. This represents 10.7% of its standard deviation (standardized beta coefficient). If one scales the effect by the median within-firm standard deviation the result is even stronger and equal to 14.3%. Columns 3 to 5 provide some robustness exercises. Column 3 excludes the six industries whose output prices may occasionally contain a bubble component and column 4 excludes the *dotcom* years 1998-2002. Column 5 excludes simultaneously firms in those six industries and all observations in the *dotcom* years 1998-2002. The estimate of β remains highly statistically significant and economically important.

Entrants *versus* incumbents

As shown above, when stock prices deviate from fundamentals, the number of firms going public tends to increase. Do stock market entrants exhibit different investment sensitivities to industry overvaluation than incumbents? To answer some these questions, I will group firms according to their stock market age and define the binary variable

$$\text{YOUNG}_{i,t} = \begin{cases} 1 & \text{if AGE}_{i,t} \leq 5 \\ 0 & \text{if AGE}_{i,t} > 5 \end{cases}$$

where $\text{AGE}_{i,t}$ is the number of years since the IPO of firm i, defined as the number of years since the first observation in CRSP-COMPUSTAT plus one. I then estimate an augmented version of the previous regression model

$$(\text{I}_{i,t}/\text{K}_{i,t-1}) = \alpha\ (\text{CF}_{i,t}/\text{A}_{i,t-1}) + \gamma\ \text{YOUNG}_{i,t} + \beta\ \text{PDEV}^{\text{IND}}_{i,t-1} + \delta\ \text{PDEV}^{\text{IND}}_{i,t-1} \times \text{YOUNG}_{i,t} + \lambda_i + \eta_t \quad + u_{i,t} \tag{2.18}$$

In this equation, δ captures a systematic different reaction to industry stock prices between entrants and incumbents. The results are shown in Table 8. Young firms have higher average investment rates (the estimate of γ is positive and significant), but they also tend to react proportionately more to industry price-fundamental deviations (the estimate of δ is positive and significant). The magnitude of this difference is substantial: the results in column 2 imply $\hat{\delta} > \hat{\beta}$, meaning that the reaction of entrants is on average more than twice as large as the reaction of incumbents. The results are robust to the exclusion of special industries and years (see columns 3 to 5). These regression estimates suggest that both incumbents and entrants increase investment in response to industry overvaluation, the reaction of the latter being substantially stronger. Given that entrants face more stringent credit constraints, the results corroborate the findings of Baker, Stein and Wurgler [2003] and of Campello and

Graham [2013] who show that constrained firms exhibit significantly higher investment sensitivities to stock prices. These results are also consistent with the recent theoretical literature highlighting the role of asset bubbles in the relaxation of credit constraints.

Are fundamental and non-fundamental fluctuations different?

The results discussed above indicate a significant correlation between stock market overvaluation and investment, suggesting that non-fundamental stock prices fluctuations may have real effects. In this subsection, I will ask whether fundamental and non-fundamental stock price fluctuations have a different impact on investment. Recall that the overvaluation measure $\mathrm{PDEV}^{\mathrm{IND}}_{i,t-1}$ is the difference between the logs of the industry price index and of the industry fundamental. Including them separately in equation (2.17) may not be appropriate since these two variables are measured in dollars and the dependent variable is a ratio (which makes the interpretation of the regression coefficient difficult). Therefore, instead of using the investment rate as the dependent variable, I will use the log of capital expenditures. I consider the following specification

$$\mathrm{i}_{i,t} = \alpha \text{ fundamental}^{\mathrm{IND}}_{i,t-1} + \beta \text{ price}^{\mathrm{IND}}_{i,t-1} + \lambda_i \ + \eta_t \ + \alpha_n \cdot \mathrm{t} + u_{i,t} \qquad (2.19)$$

where $\mathrm{i}_{i,t}$ is the log of capital expenditures (COMPUSTAT item #128) of firm i in year t and $\text{fundamental}^{\mathrm{IND}}_{i,t-1}$ and $\text{price}^{\mathrm{IND}}_{i,t-1}$ are the logs of the industry fundamental and price, respectively. As before, γ_i and η_t are firm and year fixed effects. $\alpha_n \cdot \mathrm{t}$ is an industry-specific time trend to control for common factors (e.g. industry specific productivity growth, demand trends) affecting both the dependent and the explanatory variables.[49] This specification has the advantage that the coefficients α and β can be interpreted as elasticities. Equation (2.19) is again estimated with OLS with the standard errors clustered at the industry level, the results being reported in Table 9. Columns 1 and 2 show the results when the industry fundamental and price are included separately, and column 3 reports the coefficient estimates of α and β when the full model is considered. As we can see, both coefficient estimates are positive and statistically significant. The coefficient β can be interpreted as the investment elasticity to a non-fundamental change in

---

[49] See Wooldridge [2009], pp. 363-364.

industry stock prices (i.e. a change in the price not matched by a change in the fundamental). A 1% increase in the bubble component of industry stock prices predicts a 0.393% increase in firm level investment. The investment elasticity to the fundamental component of industry prices is given by $\alpha + \beta$. A 1% increase in the fundamental component of industry stock prices predicts a 0.583% increase in firm level investment. Note that coefficient on β is shown to be positive and statistically significant, meaning that firms respond more strongly to changes in the fundamental as opposed to the non-fundamental component of industry prices.

To again assess whether young firms and incumbents exhibit different investment sensitivities to the fundamental and overvaluation component of industry stock prices, I consider an augmented version of the previous model

$$\begin{gathered}\mathrm{i}_{i,t} = \alpha \text{ fundamental}^{\mathrm{IND}}_{i,t-1} + \beta \text{ price}^{\mathrm{IND}}_{i,t-1} + \lambda_i \ + \eta_t \ + \alpha_n \cdot \mathrm{t} \\ +\gamma \text{ YOUNG}_{i,t} + \alpha_{\mathrm{Y}} \text{ fundamental}^{\mathrm{IND}}_{i,t-1} \times \text{YOUNG}_{i,t} + \beta_{\mathrm{Y}} \text{ price}^{\mathrm{IND}}_{i,t-1} \times \text{YOUNG}_{i,t} + u_{i,t}\end{gathered} \tag{2.20}$$

where $\text{YOUNG}_{i,t}$ is as defined above. The OLS estimates are shown in Table 10. Taking the baseline results from column 3, two facts should be highlighted. First, young firms exhibit a higher elasticity to both the fundamental (positive and significant $\hat{\alpha}_{\mathrm{Y}} + \hat{\beta}_{\mathrm{Y}}$) and the non-fundamental component of stock prices (positive and significant $\hat{\beta}_{\mathrm{Y}}$). Second, such higher sensitivity seems particularly stronger for the overvaluation component of industry stock prices. In response to a 1% increase in industry fundamentals, incumbents increase investment by 0.583%, while young firms increase by 0.635% (an additional 0.052 percentage points). However, if the non-fundamental component of stock prices increases by 1%, incumbents increase investment by 0.329%, whereas young firms increase by 0.578% (an additional 0.249 percentage points). That is, incumbents and young firms exhibit reactions of identical magnitude with respect to the fundamental component of stock prices. However, young firms display a much higher sensitivity to the overvaluation component. Overall, these results corroborate the previous findings: young firms react proportionately more to industry non-fundamental price fluctuations.

2.5.3 Productivity Growth

The results shown above indicate a positive correlation between stock market overvaluation and capital accumulation, which happens to be particularly strong for young firms. To provide a more complete picture of the real side of stock market overvaluation, I will look at the behavior of productivity growth. The literature has not yet explicitly looked at the relationship between overvaluation and productivity from empirical perspective, despite this being a central aspect of recent models.[50] I start by defining total factor productivity as

$$\text{TFP}_{i,t} \equiv \log\left(\frac{\text{SALE}_{i,t}}{\text{IPI}_{i,t}}\right) - 0.6\log\left(\text{EMP}_{i,t}\right) - 0.4\log\left(\frac{\text{CAPITAL}_{i,t}}{\text{CPI}_t}\right)$$

where sales, employment and the capital stock are as defined before and CPI_t and $\text{IPI}_{i,t}$ are respectively the consumer price index and an industry specific gross output deflator.[51] The labor and capital shares are fixed and equal to 0.6 and 0.4, respectively. Different numbers were considered in robustness exercises not reported in this paper (including industry-specific shares) and the results were found to be identical. To reduce the effect of outliers, the two measures are Windsorized at the 1% and 99% percentiles. Before proceeding, two issues should be highlighted. First, sales or total revenues are a measure of gross output, hence including the value of intermediate goods (energy, materials, ...) used in production. These are not treated as a production input in the above definitions simply because COMPUSTAT does not contain information on intermediate goods usage. Second, the TFP measure described above may reflect a variety of factors, from technological efficiency to management practices or simply capacity utilization. Therefore, positive variation in this measure can be for instance driven by either the availability of a better technology or by a reduction in excess capacity.

I will consider the following empirical specification

$$\Delta\text{TFP}_{i,t} = \beta\ \text{PDEV}^{\text{IND}}_{i,t-1} \ + \lambda_i \ + \eta_t \quad + u_{i,t} \tag{2.21}$$

i.e., TFP growth $\Delta\text{TFP}_{i,t}$ is regressed on one lag of the industry price-fundamental gap $\text{PDEV}^{\text{IND}}_{i,t-1}$ and on firm and year fixed effects. Table 11 shows the OLS estimates of equation (2.21). There seems to be a positive correlation between stock market overvaluation and TFP growth, but this is however relatively weak in magnitude and not statistically different from zero is most cases (columns 1 to 3). Only

---

[50] See for instance Martin and Ventura [2012], Miao and Wang [2012] and Tang [2017].

[51] The consumer price index is obtained from the Bureau of Labor Statistics and the gross output deflator is from the NIPA tables.

when the bubbly goods industries and the *dotcom* years are excluded, the coefficient appears to be statistically significant different from zero (column 4). Overall, the results indicate that overvaluation does not seem to be associated with a decline of average firm-level TFP.

These results may however hide a heterogeneous behavior between incumbents and new firms. To assess this hypothesis, I will estimate an augmented version of equation (2.21) that includes an interaction between $\text{PDEV}^{\text{IND}}_{i,t-1}$ and the binary variable $\text{YOUNG}_{i,t}$ defined above.

$$\Delta\text{TFP}_{i,t} = \gamma\ \text{YOUNG}_{i,t} + \beta\ \text{PDEV}^{\text{IND}}_{i,t-1} + \delta\ \text{PDEV}^{\text{IND}}_{i,t-1} \times \text{YOUNG}_{i,t}\ + \lambda_i\ + \eta_t\quad + u_{i,t} \tag{2.22}$$

The results are shown in Table 12. As one can see, incumbents tend to display faster productivity growth in response to an increase in the industry price-fundamental gap (positive estimate $\hat{\beta}$). The regression coefficient $\hat{\beta}$ is however significant only when we exclude the industries whose goods can occasionally include a bubble component in their prices (columns 2 and 4). Young firms tend to experience faster TFP growth than incumbents (positive estimate $\hat{\gamma}$). However, in response to an increase in the industry price-fundamental deviation, young firms exhibit lower TFP growth. These results hold in the baseline sample (column 1) and seem robust to the exclusion of special industries and years. Therefore, and compared to incumbents, young firms seem to display faster capital accumulation but lower TFP growth in response to industry stock market overvaluation.

These results refer to the growth rate of TFP, but are not informative about the actual level of productivity displayed by entrants. This will be object of analysis of section 2.6.1. Before proceeding, I briefly characterize the behavior of employment growth and some financial variables often considered in the literature.

2.5.4 Other Variables

To conclude this section, I ask whether stock market overvaluation also affects other real variables (employment growth) or financial decisions (long term debt issuance, leverage, total payout and equity issuance). I will adopt the baseline specification used before, with each dependent variable being regressed on cash-flow over assets and the lagged industry-price fundamental deviation (including year and firm fixed effects). First, I consider firm-level employment growth $\Delta\text{EMP}_{i,t}/\text{EMP}_{i,t-1}$ (COMPUSTAT item #29). The results are reported in Table 13 and indicate a quite significant association between overvaluation and employment growth. The economic magnitudes are also economically important. Taking the estimates from column 2, a one standard deviation increase in the price-fundamental deviation predicts a 0.0297 increase in employment growth. This represents 8.0% of its standard deviation and 10.7% of the median within-firm standard deviation.

Finally, I look at the behavior of some financial variables often considered in the literature (Baker, Stein and Wurgler [2003] and Campello and Graham [2013]). Define $\text{LD}_t/\text{A}_{t-1}$ as the ratio of net long term debt issue (COMPUSTAT item # 111 - item # 114) to the beginning of the period total assets (COMPUSTAT item #6).[52] Let $\text{PAY}_t/\text{A}_{t-1}$ be the payout ratio, defined as the sum of common dividends (COMPUSTAT item #21) and net stock repurchases (COMPUSTAT item #115 - item #108 - Δ item #56), divided by the beginning of the period total assets (COMPUSTAT item #6). Let LEV_t be the leverage ratio, constructed as debt (COMPUSTAT item #9 + item #34) divided by debt plus the book value of equity (COMPUSTAT item #9 + item #34 + item #216). Finally, let $mathbbm1_t^{\text{ISS}}$ be a binary variable that takes value 1 if total payout is negative (and zero otherwise). Table 14 shows the results for long term debt issuance. As one can see, there is a strong correlation between industry overvaluation and long term debt issuance, which seems robust to the exclusion of special industries and years. This finding contrasts with the results in Campello and Graham [2013], who find no statistical association between overpricing and long term debt issuance.[53] Table 15 shows the results for the total payout ratio and Table 16 for the equity issuance indicator variable. The evidence seems quite clear: firms tend not only to reduce total payout but become more likely to issue new equity in response to industry overvaluation. This evidence is consistent with the findings of Campello and Graham [2013]. Finally, Table 17 shows the results for the leverage ratio. As we can see, stock market overvaluation seems to have an impact on the capital structure: firms tend to reduce their leverage in response to an increase in the industry price-fundamental deviation.

---

[52] Scaling net long term debt issuance by lagged total debt would lead to very similar results.

[53] Campello and Graham [2013] focus on non-tech manufacturing firms in the dotcom years 1995-1995.

2.6 Stock Market Overvaluation and Entrants' Characteristics

Do non-fundamental stock price fluctuations help productive firms become public? Or do they instead promote the entry of relatively inefficient firms? These are important questions that deserve a detailed examination. On the one hand, and in line with some of the evidence for the *dotcom* bubble reviewed above, there is the idea that overvalued stock prices may boost the entry of unproductive firms. Recent models of firm dynamics (such as Tang [2017]) also suggest that asset bubbles may help relatively unproductive and constrained firms enter/expand. On the other hand, theoretical models such as Martin and Ventura [2012] and Miao and Wang [2012] hypothesize that asset bubbles may bring about an efficient reallocation of resources form unproductive to productive firms. In this section, I address some of these questions by looking at the correlations between industry overvaluation and entrants' productivity.

2.6.1 Overvaluation and the Relative TFP of Entrants

The objective of this section is to look for a systematic correlation between industry overvaluations and the productivity of entrants. I will look at firms listed for five or less years (which I treat as stock market entrants) and for each age cohort I will regress the current TFP level on the industry-price fundamental deviation in the year prior to entry.[54] Therefore, for each age cohort $j = 1, 2, 3, 4$ and 5 , I consider a separate regression of the form

$$\text{TFP}_{i,t} = \mu_n + \gamma_t + \alpha_n \cdot \text{t} + \beta \cdot \text{PDEV}^{\text{IND}}_{i,t-j} + z_{i,t} \quad , \ \text{AGE}_{i,t} = j \tag{2.23}$$

In this specification, total factor productivity of age-j firms is regressed on $\text{PDEV}^{\text{IND}}_{i,t-j}$, i.e. the price-fundamental deviation in the year prior to entry. μ_n and γ_t capture industry and time fixed effects. An industry specific time trend $\alpha_n \cdot$ t is also included since different industries may exhibit different rates of productivity growth.

---

[54] Recall that $\text{AGE}_{i,t}$ is defined as the number of years since the IPO of firm i, defined as the current year t minus the year of the first observation in COMPUSTAT (plus one).

The regressions are estimated with OLS and standard errors are clustered at the industry level. The results are shown in Table 18 for the full sample period 1981-2013 and when all industries are included. Columns 1 to 5 report the coefficients estimates for each age cohort $j = 1, 2, 3, 4$ and 5 of the previous regression equation. The first point to note is a strong negative correlation between the productivity of firms in the year of entry and the lagged price-fundamental deviation (column 1). This correlation seems to have a sizable economic magnitude: a one standard deviation increase in the industry price-fundamental deviation, predicts a -0.085 decrease in the average entrants' TFP, which represents 9.17% of its standard deviation (column 1). The results shown in columns 2 to 5 indicate that this effect happens to be persistent. In times of pronounced overvaluation, entrants not only start with low average productivity, but their average productivity remains low after five years. Note that not all firms reach their fifth year: some may go bankrupt, others may merge or be acquired by other firms, others may simply become unlisted.[55]

The evidence presented here indicates a strong negative correlation between industry overvaluation and the productivity of entrants. Do incumbents manifest a similar behavior? The evidence shown in section 2.5 suggests a positive relationship between TFP growth of incumbents and industry overvaluation, though not statistically significant in some samples. To confirm this result, I consider a specification similar to (2.23) for incumbents (firms listed for more than five years)

$$\text{TFP}_{i,t} = \mu_i + \gamma_t + \alpha_n \cdot \text{t} + \beta \cdot \text{PDEV}^{\text{IND}}_{i,t-1} + z_{i,t} \tag{2.24}$$

i.e. the TFP level of incumbents is regressed on one lag of the industry price-fundamental deviation, on firm and year fixed effects and on an industry-specific time trend. The results are shown in Table 19. Consistent with our earlier results and contrarily to the evidence shown for entrants, there seems to be a positive association between industry overvaluation and the productivity of incumbents. As already discussed, this correlation may not necessarily reflect the availability of better or more efficient technologies, but can also indicate higher capacity utiliza-

---

[55] Identical results are obtained when excluding industries whose output prices may contain a bubble component and/or cohorts entering in the dotcom years 1998-2002.

tion. To ascertain these hypotheses, Table 20 reports the results for an augmented version of (2.24) that includes five lags of the industry price-fundamental deviations. The results confirm a positive correlation with TFP an industry overvaluation at one lag. At more than one lag, the correlation is typically negative, though substantially weaker in magnitude and not statistically different from zero. The results of Table 20 therefore indicate that industry overvaluation does not seem to have a persistent impact on the TFP level of incumbents. There is a positive correlation with price-fundamental ratios and incumbents' TFP at one lag, but the effect dies away immediately. The evidence therefore suggests an interpretation based on higher capacity utilization, since an increase in TFP driven by technological adoption would likely be more persistent.

The results discussed so far point towards a disparate reaction by entrants and incumbents to industry overvaluation: incumbents seem to temporarily increase capacity utilization, whereas entrants seem to enter with persistently lower productivity levels or with excess capacity. This suggests a deterioration in the entrants-incumbents productivity gap. To more formally assess this hypothesis, I will ask if there is a systematic correlation between the entrants-incumbents productivity gap and industry overvaluation. Let $\mathrm{TFP}_{i,t}^{\mathrm{gap}}$ be the difference between the TFP of firm i in year t and the median TFP of incumbents in the same industry and year.[56] For each age cohort $j = 1, 2, 3, 4$ and 5 , I consider the following specification

$$\mathrm{TFP}_{i,t}^{\mathrm{gap,50}} = \mu_n + \gamma_t + \beta \cdot \mathrm{PDEV}_{i,t-j}^{\mathrm{IND}} + z_{i,t} \quad , \ \mathrm{AGE}_{i,t} = j$$

i.e., the TFP gap between age j firms and incumbents (firms with more than five years) is regressed on $\mathrm{PDEV}_{i,t-j}^{\mathrm{IND}}$, i.e. the price-fundamental deviation in the year prior to entry. μ_n and γ_t capture industry and time fixed effects. Table 21 shows the coefficient estimates for each one of the five regressions. As expected, there is a strong negative correlation between the entrants-incumbents productivity gap and overvaluation. When stock prices deviate from fundamentals, the pool of firms going public tend to have a significantly lower productivity gap than incumbents. Looking at column 1, a one standard deviation increase in the industry

---

[56] Note that the distinction between revenue and physical TFP is irrelevant for this definition as long as entrants and incumbents experience similar price changes (as assumed before).

price-fundamental deviation, predicts a -0.095 decline in the entrants-incumbents productivity gap, which represents 10.0% of its standard deviation. The deterioration on the entrants-incumbents productivity gap seems also to be persistent.

All in all, two clear results seem to emerge. When industry stock prices deviate from fundamentals (i) incumbents seem to experience an increase in TFP (which is likely to be driven by higher capacity utilization) and (ii) stock market entrants are on average less productive. Note however that the entry of relatively unproductive firms may still be an efficient outcome. Indeed, the model of Tang [2017] suggests that in the presence of credit market frictions, firms may enter with inefficiently high productivity levels. Stock market bubbles may help these firms efficiently expand, even if at the expense of a TFP decline. But do asset bubbles always help constrained firms enter and expand? May some of the bubbles we observe be too large? This is a question that I will try to answer in the next section.

2.6.2 Do Entrants Overissue Equity?

A conclusion of the theoretical literature studying the role of asset bubbles in the presence of financial frictions is that bubbles can be welfare improving insofar as they relax credit constraints. However, if they become too large, they may crowd out productive investments (Martin and Ventura [2012, 2016]). Are some of the bubbles we observe too large? And how to tackle this question empirically? In this section, I look at the relationship between equity issuance and investment for stock market entrants and how it is affected by industry overvaluation. Since stock market entrants are likely to be unknown and lack internal funds, they may face particularly stringent credit constraints. If this is indeed the case, when stock prices deviate from fundamentals, constrained entrants should use the additional funds raised in the stock market to finance new investment projects. If they however issue more equity relative to future investment levels, credit constraints are likely to be no longer binding. In such case, asset bubbles can be too large (for at least some firms).

Following Baker, Stein and Wurgler [2003], each firm's IPO date is taken as the year of the first observation with non-missing market value data in the CRSP-COMPUSTAT database. I will restrict attention to firms in the year of their IPO.

For a given firm i having its IPO in year t, define $\text{ISS}^1_{i,t}$ as the amount of its (net) equity issuance.[57] Moreover, let

$$\text{CINV}^{\text{T}}_{i,t} = \sum_{j=0}^{T-1} \text{INV}_{i,t+j}$$

be its cumulative investment over T years (given by COMPUSTAT item #128). If the firm is listed for less than T years, this variable is not defined. I will consider the following specification

$$\left(\text{ISS}^1_{i,t}/\text{CINV}^{\text{T}}_{i,t}\right) = \mu_n + \gamma_t + \beta \cdot \text{PDEV}^{\text{IND}}_{i,t-1} + z_{i,t} \quad , \ \text{AGE}_{i,t} = 1 \tag{2.25}$$

The dependent variable is the amount of equity issued during the IPO, scaled by total investment over the firms' first T years.[58] This variable is regressed on the industry price-fundamental deviation prior to IPO and on industry and time fixed effects. If overvaluation makes entrants overissue stock in excess of their investment needs or opportunities, one expects a positive β. Table 22 shows the OLS estimates of equation (**??**) for three different time windows $T = 5, 10,$ and $15.$ As we can see, the estimates of β are always positive and significant. This suggests that overvaluation can make entrants overissue stock relative to their future investment levels. Taking the results in column 2, a one standard deviation increase in $\text{PDEV}^{\text{IND}}_{i,t-1}$ predicts a 0.250 increase in $\left(\text{ISS}_{i,t}/\text{CINV}^{10}_{i,t}\right)$ which represents 30.1% of its standard deviation and 16.6% of its standard deviation. The results reported in the first three columns of Table 33 consider equity issued in the year of entry. Columns 4 to 6 show that similar results are obtained if one looks at the cumulative equity issued over the initial 5 years.

Do these results indicate that entrants overissue equity or simply substitute of equity for debt? To answer this question, I repeat the above procedure, but now looking at long term debt issuance by entrants (instead of equity issuance). The

---

[57] Equity issuance is defined as the sale of common and preferred stock (COMPUSTAT item #108) minus the purchase of common and preferred stock (COMPUSTAT item #115). The results would be identical if common dividends were also subtracted, essentially because entrants typically do not pay dividends.

[58] This ratio is Windsorized at the 1% and 99% percentiles.

results are reported in Table 23. As one can see, entrants do not seem to reduce their long term debt issuance relative to their investment levels. Although the coefficient estimates are negative in some cases, they appear to be both statistically and economically insignificant. Therefore, all the above results are unlikely driven by a substitution of equity for debt.

The results shown in this section suggest that in periods of industry overvaluation, stock market entrants may issue too much equity. Indeed, they seem to suggest that overvaluation may sometimes be sufficiently large so as to override credit constraints as firms do not use all their funds to finance additional investment projects. This raises the question as to whether asset bubbles may sometimes be too large. A conclusion in the recent theoretical literature studying the effects of asset bubbles in the presence of credit market imperfections is that bubbles may be welfare improving insofar as they relax credit constraints. This typically happens when asset bubbles are relatively small and firms are constrained (Martin and Ventura [2012, 2016]). However, if bubbles get too large and firms become unconstrained, the economic benefits of asset bubbles may disappear. In such case, asset bubbles are likely to absorb too much resources and crowd out productive investments.

Are some of the bubbles we observe too large? This is obviously a highly relevant question, but difficult to answer empirically. The results shown in this section provide some suggestive evidence that asset bubbles may at least be sufficiently large so as to override firms' credit constraints.

2.7 Conclusion

Stocks prices are known to be too volatile and are thought of as important drivers of business cycle fluctuations. This paper provides a time series description of stock market overvaluation at the industry level and shows how overvaluation is related to some real variables, such as stock market entrants' characteristics or firm-level productivity. Contrarily to most related studies in the literature, (i) fundamentals were calculated with a methodology that has a strong theoretical underpinning (the Campbell and Shiller [1988b] methodology) and (ii) the analysis was conducted at the industry level.

Consistent with prevailing views, I documented a large deviation between stock prices and fundamentals in a group of technological industries in the late 1990s. However, I found a relatively small price-fundamental gap in the construction sector in the years 2004-2006. This indicates that the price of construction firms closely reflected market expectations of future dividend growth. I have also shown that the non-fundamental component of stock prices appears to be more volatile in industries with higher profit margins and higher R&D intensities. This finding suggests that stock market bubbles are more likely to appear in industries with certain characteristics and offers useful guidance for future theoretical models.

This paper also documents a strong correlation between stock market overvaluation and firm level investment. Young firms were shown to exhibit higher investment sensitivities to industry stock prices, particularly with respect to their non-fundamental component. Overall, and to the extent that young firms are more likely to be credit constrained, these results are consistent with the recent theoretical literature suggesting that asset bubbles can help firms overcome financial frictions (Martin and Ventura [2011, 2012, 2016], Miao and Wang [2012] and Tang [2017]).

As shown in this paper, young firms not only exhibit faster capital accumulation in response to industry overvaluation, but also lower TFP growth rates. Furthermore, firms entering in the stock market in periods of high overvaluation are shown to be on average less productive. This finding is consistent with recent models focused on the interactions between asset bubbles and firm dynamics (such as Tang [2017]). They also highlight the importance of the entry margin and suggest that issues pertaining to industry dynamics and the market structure should be considered in future research.

Also interesting to note is the fact that when prices deviate from fundamentals, stock market entrants seem to overissue equity. As shown in section 2.6, stock market entrants issue significantly more equity relative to their future investment levels, but do not seem to reduce debt issuance. These facts suggest that stock market bubbles may sometimes be large enough so as to override firms' credit constraints. This observation raises some questions for future work. For instance, a conclusion in the recent theoretical literature studying the effects of asset bubbles in the presence of credit market imperfections is that bubbles may be welfare improving insofar as they relax credit constraints. Are some of the bubbles we observe too large? This is an important empirical question, particularly relevant for policy makers.

This paper offers further hints for future research. The idea that stocks can be a portfolio of two underlying assets (the *fundamental* and the *bubbl*e) with different required returns was shown to have important consequences. The model outlined in section 2.2 illustrated a major identification problem: if the fundamental and the bubble can have different required returns, these may not be retrievable from observed prices and dividends. A second and related finding is that stock returns may exhibit positive serial correlation even when the returns on the two underlying assets have zero autocorrelation. This happens because the share of each component in the total price may exhibit some persistence. For instance, as the relative size of the bubble increases (shrinks), its expected return will account for a larger share of the expected return on the total price. As discussed above, this possibility may provide a simple explanation to some well-known facts, such as the excess price return predictability using dividend-price ratios or lagged price returns (Campbell and Shiller [1988b]). A serious evaluation of this hypothesis is an interesting avenue for future work.

The discussion of the 2004-2006 housing boom also suggested a conceptual distinction between bubbles attached to the price of firms and bubbles attached to the price of goods. Despite being conceptually different objects, it is not clear whether these different types of bubbles can have different real consequences. A theoretical analysis of these issues should also be pursued in future research.

Finally, it would be interesting to have a characterization of overvaluation at the firm level. As non-fundamental stock price fluctuations can be related to industry characteristics, there may also be systematic patterns across different firm classes. At the firm level, how does overvaluation relate to size, age or leverage? When stock prices depart from fundamentals, do we observe identical deviations across financially constrained and unconstrained firms? These questions are left for future research projects.

2.8 Appendix 1: Derivation of Equation (2.9)

First note that we can write the time t bubble as a function of current dividends and the initial bubble B_0

$$B_t = \theta D_t + \left(1 + r^B\right) \underbrace{\left[\theta D_{t-1} + \left(1 + r^B\right) B_{t-2}\right]}_{B_{t-1}}$$

$$B_t = \theta D_t + \frac{1 + r^B}{1 + g}\theta D_t + \left(1 + r^B\right)^2 \underbrace{\left[\theta D_{t-2} + \left(1 + r^B\right) B_{t-3}\right]}_{B_{t-2}}$$

$$B_t = \theta D_t + \frac{1 + r^B}{1 + g}\theta D_t + \left(\frac{1 + r^B}{1 + g}\right)^2 \theta D_t + \left(1 + r^B\right)^3 B_{t-3}$$

$$B_t = \cdots$$

$$B_t = \left(1 + r^B\right)^t B_0 + \theta D_t \cdot \sum_{s=0}^{t-1} \left(\frac{1 + r^B}{1 + g}\right)^s$$

Plugging this equation into

$$\frac{P_t}{D_t} = \frac{1 + g}{r^F - g} + \frac{B_t}{D_t}$$

and noting that $D_t = (1 + g)^t D_0$ we have that

$$\frac{P_t}{D_t} = \frac{1 + g}{r^F - g} + \left(\frac{1 + r^B}{1 + g}\right)^t \frac{B_0}{D_0} + \theta \cdot \sum_{s=0}^{t-1} \left(\frac{1 + r^B}{1 + g}\right)^s$$

2.9 Appendix 2: Variables Construction

2.9.1 Industry Indexes

Several industry aggregates are constructed. Naturally, one needs to correct for the mechanical effects due to the listing and delisting of firms. I will follow standard practices and apply a correction factor to all variables. The correction factor is chosen so that changes in aggregate market capitalization cannot be attributable to the addition or deletion of firms from the dataset.[59] To make it clear, let $mv_{j,t}$ be the market value of firm j in year t. Let S_t^0 be the set of active firms in the same industry at year t that already existed in $t-1$. Let S_t^1 be the set of active firms at year t that are also active in year $t+1$. The correction factor applied at year t is denoted by γ_t and is recursively defined as[60]

$$\gamma_t = \gamma_{t-1} \frac{\sum_{j \in S_t^0} mv_{j,t}}{\sum_{j \in S_t^1} mv_{j,t}}$$

Given this definition, for any firm level variable $x_{i,t}$ the corresponding aggregate variable X_t is constructed as

$$X_t := \gamma_t \sum_{j \in S^1} x_{j,t}$$

I construct industry aggregates for market capitalization, dividends and operating profits.

2.9.2 Capital Stock

COMPUSTAT contains information on the book value of capital. However, this is reported at its cost of acquisition, and not at its market value. To address this concern, I construct an alternative capital stock measure using a perpetual inventory method and assuming a constant 10% depreciation rate. This variable is then deflated by the CPI.

---

[59] This is the basic methodology underlying the construction of most market aggregates such as the S&P 500 total market capitalization, dividends or earnings.

[60] Note that the set of firms that transition from t to $t+1$ corresponds to the set of firms existing at $t+1$ that were active in the previous period: $S_t^1 = S_{t+1}^0$.

2.10 Appendix 3: Industry Classification

Number	Industry Name	NAICS Code	Number of Firms			Market Capitalization (Billion $)		
			Min	Max	Median	Min	Max	Median
1	Oil and Gas Extraction	21	84	223	123	35.4	469.4	103.2
2	Mining	212-3	42	81	60	22.2	247.3	58.3
3	Construction	23	46	84	64	8.7	83.6	20.5
4	Food and Beverages Manufacturing	311-2	60	134	93	87.5	686.4	456.1
5	Textile Mills	313-4	6	43	31	3.2	18.3	6.3
6	Apparel Manufacturing	315-6	25	90	65	7.6	87.2	34.0
7	Wood Products	321	6	41	25	2.6	27.1	14.7
8	Paper Products	322	20	55	42	38.4	154.0	100.7
9	Printing Activities	323	10	37	28	3.6	20.8	12.5
10	Petroleum and Coal Products	324	15	34	28	168.6	687.0	311.2
11	Chemical Products	325\3254	74	142	113	127.8	519.3	318.6
12	Pharmaceuticals	3254	50	291	215	104.4	1636.7	591.9
13	Plastics and Rubber Products	326	18	67	54	9.3	35.3	17.6
14	Non Metallic Mineral Products	327	10	46	28	4.9	24.9	13.5
15	Primary Metals	331	28	78	52	27.7	95.2	42.3
16	Metal Products Manufacturing	332	39	102	80	23.5	107.8	46.2
17	Machinery Manufacturing	333	111	244	192	55.5	581.3	181.0
18	Computer and Peripheral Equipment	3341	33	147	114	31.5	726.7	177.2
19	Communications Equipment	3342-3	52	157	113	10.6	301.6	53.3
20	Semiconductors	3344	68	183	143	20.9	823.0	200.7
21	Other Electronic Products	3345-6	99	234	180	32.2	317.0	119.3
22	Electrical Equipment	335	36	96	75	26.4	81.0	55.4
23	Motor Vehicle and Parts	3361-3	39	89	59	31.7	180.2	95.4
24	Aerospace and Other Transportation Equipment	3364-9	28	48	40	34.8	257.6	108.9
25	Furniture	337	10	42	31	3.4	18.2	8.3
26	Medical Equipment	3391	30	115	82	8.7	130.5	48.0
27	Miscellaneous Manufacturing	3392-9	22	71	47	5.1	36.7	22.1
28	Wholesale Trade	42	68	228	167	24.9	147.3	83.4
29	Retail Trade	44-5	72	311	225	69.6	995.8	361.9
30	Transportation	48-9	58	133	103	61.1	256.0	137.6
31	Publishing Industries	511	41	338	144	17.1	1429.6	265.5
32	Media	512,5	39	97	66	29.6	410.9	135.8
33	Telecommunications	517	26	125	71	93.5	1168.9	344.2
34	Information and Data Processing Services	518-9	16	138	65	8.4	443.7	62.9
35	Real Estate	531	19	56	39	3.8	44.9	10.6
36	Professional and Technical Services	541	78	293	191	79.9	749.7	188.0
37	Administrative and Support Services	561	38	117	65	12.2	96.8	43.3
38	Education	611	6	22	18	1.2	37.0	8.6
39	Health Care	621-3	19	137	82	4.1	97.6	54.6
40	Arts, Entertainment and Recreation	711-3	17	45	23	1.4	28.7	8.9
41	Accommodation and Food Services	721-2	57	159	91	14.3	221.0	98.4

Table 1

Number	Name	Labor Share	Profit Margin	R&D Intensity
1	Oil and Gas Extraction	0.564	0.237	0.004
2	Mining	0.649	0.184	0.017
3	Construction	0.552	0.059	0.009
4	Food and Beverages Manufacturing	0.498	0.156	0.008
5	Textile Mills	0.444	0.104	0.016
6	Apparel Manufacturing	0.227	0.122	0.006
7	Wood Products	0.339	0.110	0.006
8	Paper Products	0.209	0.158	0.021
9	Printing Activities	0.409	0.148	0.013
10	Petroleum and Coal Products	0.204	0.136	0.005
11	Chemical Products	0.769	0.161	0.031
12	Pharmaceuticals	0.769	0.249	0.127
13	Plastics and Rubber Products	0.612	0.115	0.020
14	Non Metallic Mineral Products	0.249	0.146	0.011
15	Primary Metals	0.357	0.105	0.008
16	Metal Products Manufacturing	0.306	0.134	0.015
17	Machinery Manufacturing	0.306	0.136	0.041
18	Computer and Peripheral Equipment	0.306	0.128	0.070
19	Communications Equipment	0.306	0.113	0.087
20	Semiconductors	0.306	0.194	0.102
21	Other Electronic Products	0.306	0.141	0.057
22	Electrical Equipment	0.360	0.131	0.029
23	Motor Vehicle and Parts	0.377	0.113	0.036
24	Aerospace and Other Transportation Equipment	0.364	0.108	0.036
25	Furniture	0.317	0.099	0.011
26	Medical Equipment	0.244	0.183	0.051
27	Miscellaneous Manufacturing	0.244	0.140	0.029
28	Wholesale Trade	0.360	0.049	0.002
29	Retail Trade	0.262	0.070	0.001
30	Transportation	0.270	0.139	0.057
31	Publishing Industries	0.535	0.231	0.132
32	Media	0.463	0.213	0.022
33	Telecommunications	0.636	0.311	0.021
34	Information and Data Processing Services	0.566	0.180	0.067
35	Real Estate	0.824	0.187	0.005
36	Professional and Technical Services	0.273	0.174	0.067
37	Administrative and Support Services	0.255	0.110	0.015
38	Education	0.154	0.185	0.041
39	Health Care	0.088	0.140	0.012
40	Arts, Entertainment and Recreation	0.267	0.189	0.017
41	Accommodation and Food Services	0.303	0.175	0.000

Table 2

Number	Industry Name	Avg. Dividend Growth	Avg. Price Return	Avg. Fund. Return I	Avg. Fund. Return II
1	Oil and Gas Extraction	0.030	0.078	0.058	0.114
2	Mining	0.051	0.053	0.073	0.102
3	Construction	0.000	0.045	0.015	0.025
4	Food and Beverages Manufacturing	0.062	0.109	0.103	0.136
5	Textile Mills	-0.071	0.057	-0.049	0.021
6	Apparel Manufacturing	0.054	0.106	0.084	0.108
7	Wood Products	-0.027	0.055	0.003	0.029
8	Paper Products	0.043	0.080	0.081	0.107
9	Printing Activities	0.028	0.053	0.062	0.104
10	Petroleum and Coal Products	0.047	0.090	0.098	0.145
11	Chemical Products	0.035	0.084	0.076	0.099
12	Pharmaceuticals	0.081	0.105	0.107	0.126
13	Plastics and Rubber Products	0.000	0.078	0.034	0.068
14	Non Metallic Mineral Products	-0.041	0.059	-0.016	0.021
15	Primary Metals	-0.014	0.041	0.017	0.040
16	Metal Products Manufacturing	0.037	0.079	0.069	0.092
17	Machinery Manufacturing	0.050	0.079	0.074	0.096
18	Computer and Peripheral Equipment	0.126	0.089	0.136	0.144
19	Communications Equipment	0.059	0.033	0.071	0.081
20	Semiconductors	0.101	0.085	0.113	0.122
21	Other Electronic Products	0.077	0.085	0.097	0.112
22	Electrical Equipment	0.031	0.067	0.065	0.088
23	Motor Vehicle and Parts	0.022	0.074	0.069	0.104
24	Aerospace and Other Transportation Equipment	0.070	0.097	0.105	0.136
25	Furniture	0.006	0.082	0.050	0.091
26	Medical Equipment	0.074	0.088	0.090	0.103
27	Miscellaneous Manufacturing	0.048	0.087	0.078	0.105
28	Wholesale Trade	0.055	0.092	0.079	0.096
29	Retail Trade	0.079	0.115	0.104	0.134
30	Transportation	0.064	0.077	0.091	0.110
31	Publishing Industries	0.092	0.100	0.110	0.125
32	Media	0.108	0.121	0.131	0.154
33	Telecommunications	0.022	0.079	0.066	0.102
34	Information and Data Processing Services	0.040	0.099	0.062	0.108
35	Real Estate	0.026	0.093	0.044	0.068
36	Professional and Technical Services	0.036	0.063	0.069	0.096
37	Administrative and Support Services	0.043	0.072	0.071	0.095
38	Education	0.018	0.074	0.035	0.076
39	Health Care	0.099	0.094	0.112	0.122
40	Arts, Entertainment and Recreation	0.084	0.044	0.096	0.120
41	Accommodation and Food Services	0.097	0.109	0.115	0.131

Table 3

2.11 Tables: Pooled VAR

Pooled VAR: 1980-2013

VARIABLES	(1) $\Delta d_{i,t+1} - r_t^M$	(2) $p_{i,t+1} - d_{i,t+1}$	(3) $\psi_{i,t+1}^5$
$\Delta d_{i,t} - r_{t-1}^M$	-0.112***	0.134***	-0.0174
	(0.0383)	(0.0430)	(0.0148)
$p_{i,t} - d_{i,t}$	0.448***	0.603***	-0.0515***
	(0.0331)	(0.0373)	(0.0156)
$\psi_{i,t}^5$	0.119***	0.0308	0.818***
	(0.0365)	(0.0415)	(0.0187)
Observations	1,394	1,394	1,394
R-squared	0.278	0.300	0.751

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4

This table shows the results for the panel VAR defined in equation (13). Data is from CRSP and COMPUSTAT 1980-2013, excluding utilities and financial companies. Industry variables are aggregated from firm data and a correction factor is applied to adjust for listing/delisting. See main text for definitions.

Pooled VAR: 1980-2013			
	(1)	(2)	(3)
VARIABLES	$\Delta\text{op}_{i,t+1} - r^M_t$	$p_{i,t+1}{-}\text{op}_{i,t+1}$	$\psi^5_{i,t+1}$
$\Delta\text{op}_{i,t} - r^M_{t-1}$	0.113**	0.0552	-0.169***
	(0.0517)	(0.0455)	(0.0282)
$p_{i,t}{-}\text{op}_{i,t}$	0.304***	0.698***	-0.126***
	(0.0593)	(0.0544)	(0.0325)
$\psi^5_{i,t}$	0.202***	-0.0633	0.750***
	(0.0455)	(0.0440)	(0.0290)
Observations	1,394	1,394	1,394
R-squared	0.084	0.601	0.755

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5

This table shows the results for the panel VAR defined in equation (13). Cash-flows are measured by operating profits. Data is from CRSP and COMPUSTAT 1980-2013, excluding utilities and financial companies. Industry variables are aggregated from firm data and a correction factor is applied to adjust for listing/delisting. See main text for definitions.

2.12 Tables: Price Deviations across Industries

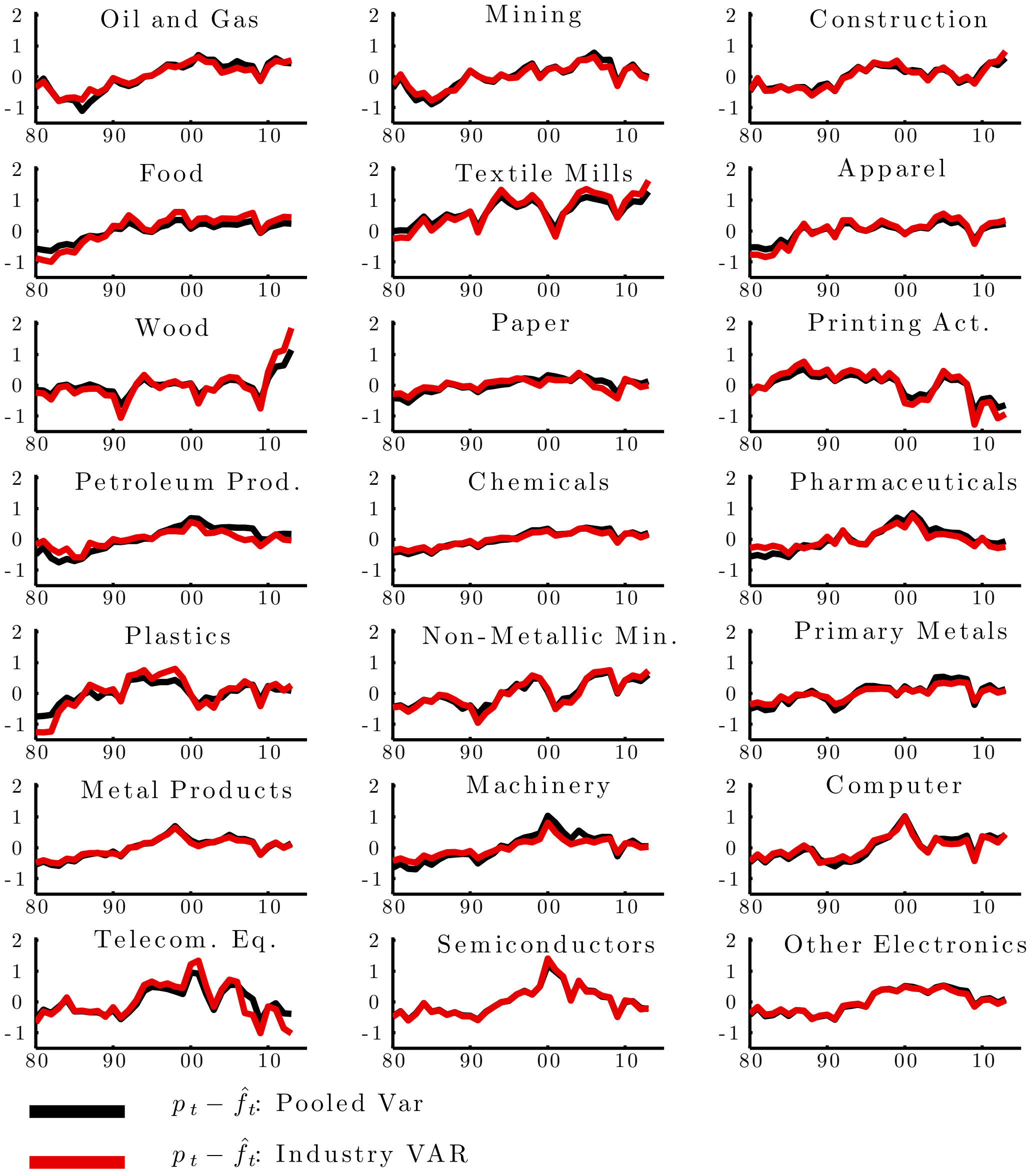


Figure 2.15: Price-Fundamental Deviation across Industries

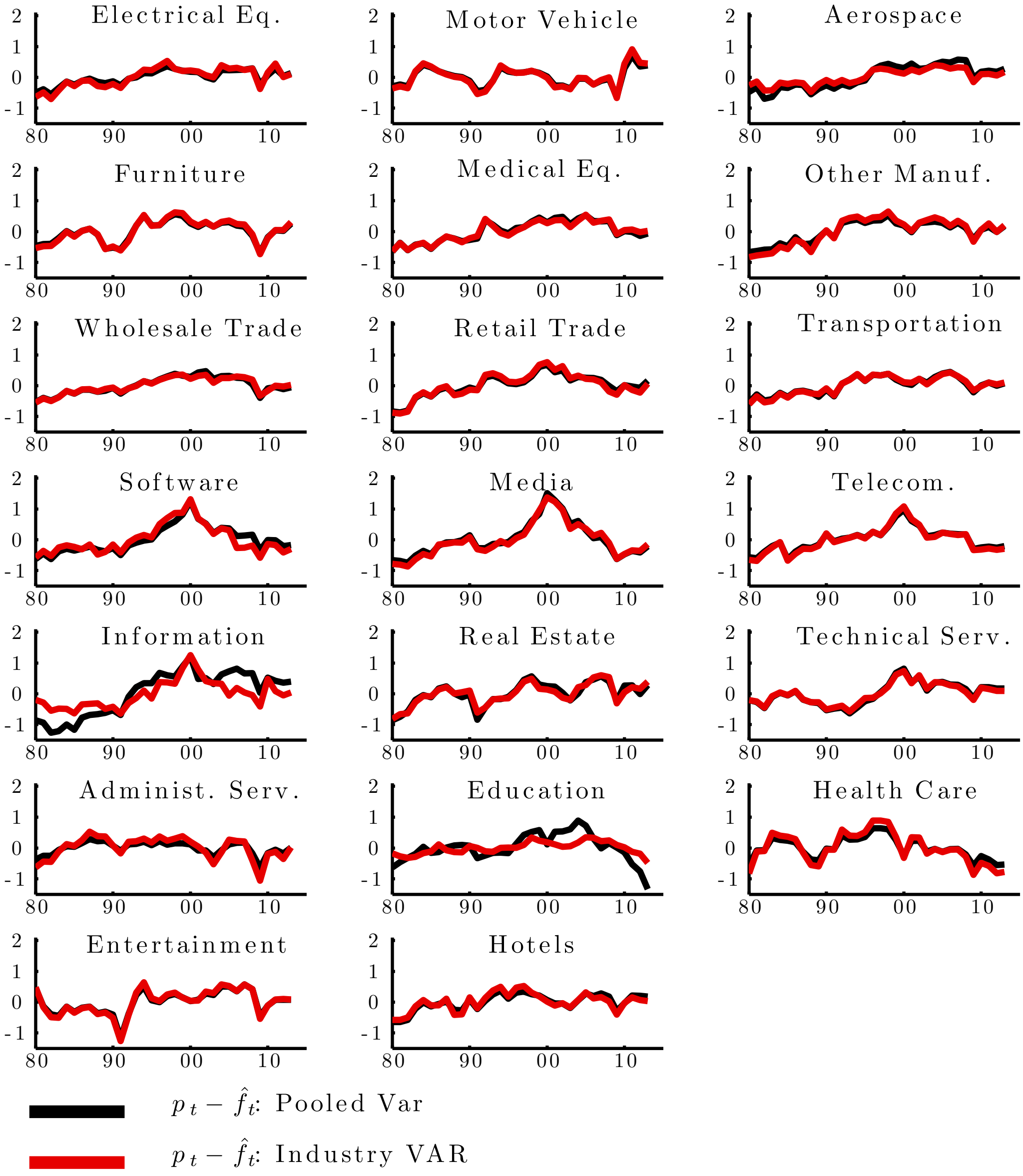


Figure 2.16: Price-Fundamental Deviation across Industries

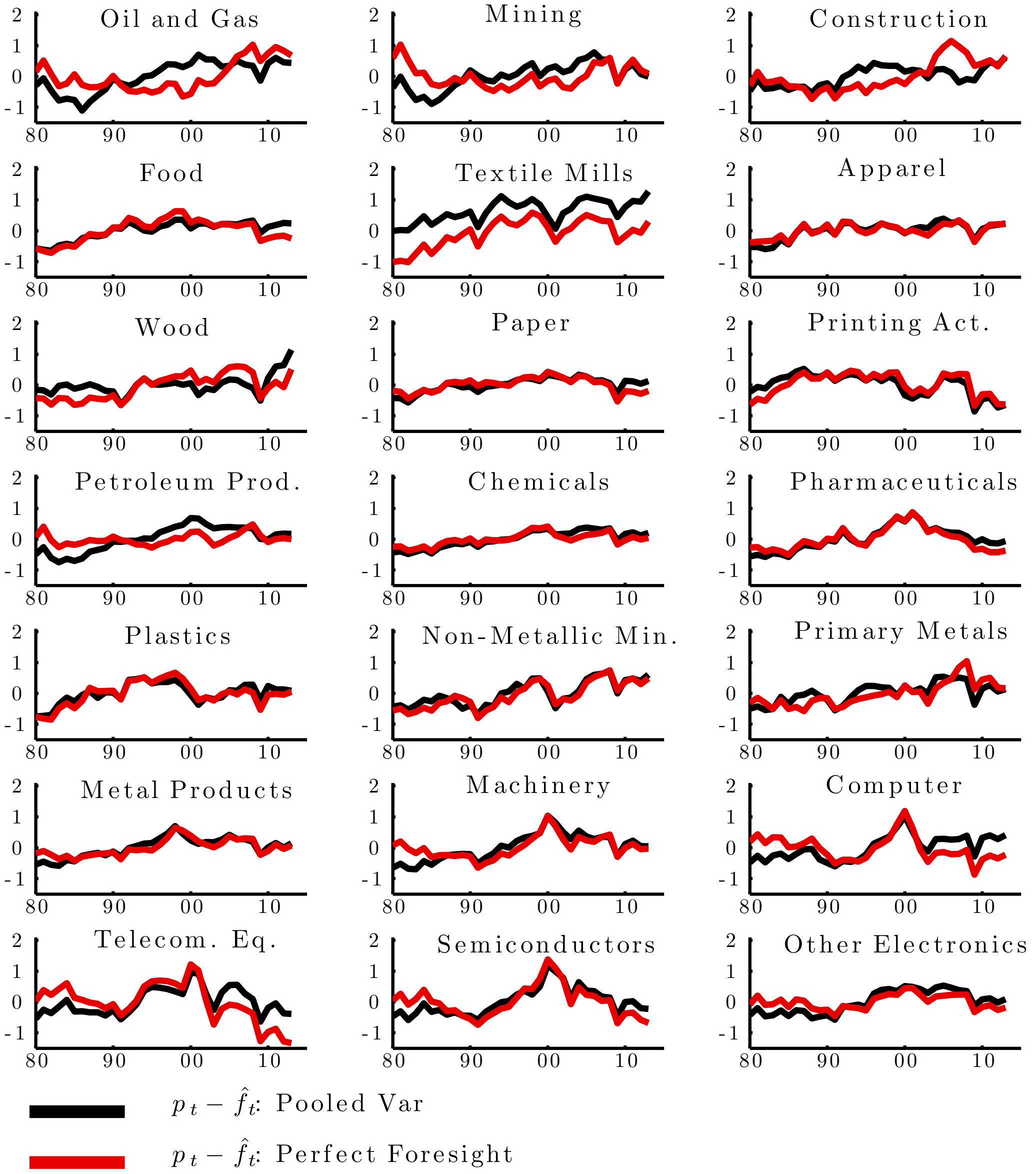
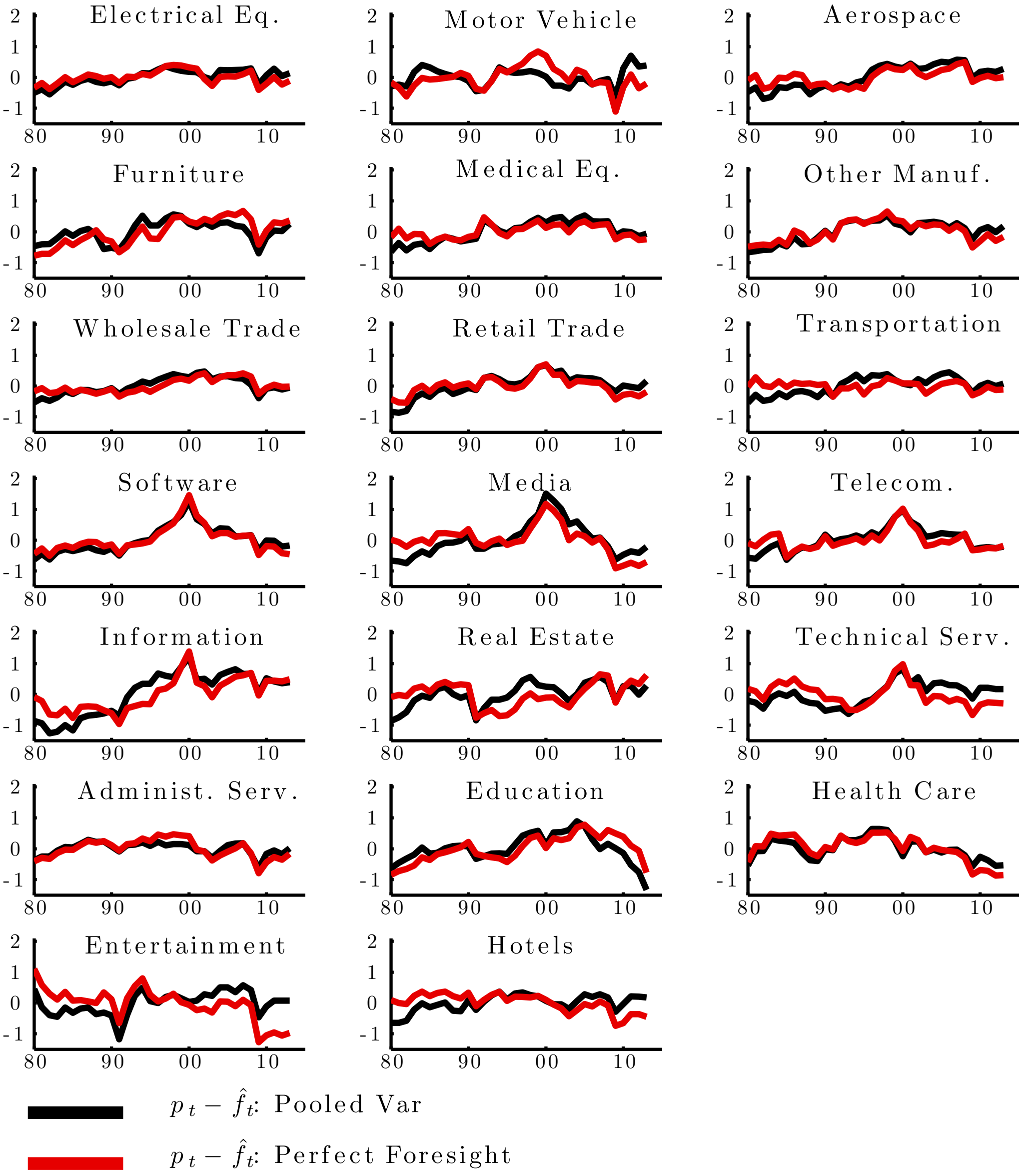


Figure 2.17: Price-Fundamental Deviation across Industries



Electrical Eq.
Motor Vehicle
Aerospace
Furniture
Medical Eq.
Other Manuf.
Wholesale Trade
Retail Trade
Transportation
Software
Media
Telecom.
Information
Real Estate
Technical Serv.
Administ. Serv.
Education
Health Care
Entertainment
Hotels

Figure 2.18: Price-Fundamental Deviation across Industries

2.13 Tables: Stock Market Entry

Price Deviation and Stock Market Entry

	(1)	(2)	(3)	(4)	(5)
	All Industries	All Industries	Excluding Bubbly Goods	All Industries	Excluding Bubbly Goods
	1981-2013	1981-2013	1981-2013	1981-1997 & 2003-2013	1981-1997 & 2003-2013
VARIABLES	N_t^{new} / N_{t-1}	N_t^{new} / N_{t-1}	N_t^{new} / N_{t-1}	N_t^{new} / N_{t-1}	N_t^{new} / N_{t-1}
ΔFUND$_{t-1}$		0.0804***	0.0730**	0.0671***	0.0453**
		[0.112]	[0.0886]	[0.0920]	[0.0527]
		(0.0243)	(0.0331)	(0.0178)	(0.0211)
PDEV$_{t-1}$	0.0376***	0.0315***	0.0282**	0.0318**	0.0289**
	[0.214]	[0.180]	[0.155]	[0.173]	[0.151]
	(0.00988)	(0.00959)	(0.0103)	(0.0122)	(0.0133)
Observations	1,353	1,353	1,155	1,148	980
R-squared	0.473	0.481	0.526	0.489	0.545
Industry FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standardized beta coefficients in square brackets

Industry-clustered standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 6

Data is from CRSP and COMPUSTAT 1981-2013, excluding utilities and financial companies. ΔFUND$_{t-1}$ is the growth rate of the industry fundamental. PDEV$_{t-1}^{IND}$ is the industry price-fundamental deviation at the end of period $t-1$, described in section 3. Bubbly industries refers to six industries whose output prices may contain a bubble component: Oil and Gas Extraction (1), Mining (2), Construction (3), Petroleum and Coal Products (10), Primary Metals (15) and Real Estate (36).

2.14 Tables: Investment

Price Deviation and Investment

	(1)	(2)	(3)	(4)	(5)
	All Industries	All Industries	Excluding Bubbly Goods	All Industries	Excluding Bubbly Goods
	1981-2013	1981-2013	1981-2013	1981-1997 & 2003-2013	1981-1997 & 2003-2013
VARIABLES	I_t / K_{t-1}	I_t / K_{t-1}	I_t / K_{t-1}	I_t / K_{t-1}	I_t / K_{t-1}
CF_t / A_{t-1}		0.159***	0.149***	0.198***	0.186***
		[0.101]	[0.0966]	[0.124]	[0.119]
		(0.0297)	(0.0299)	(0.0332)	(0.0330)
$\mathrm{PDEV}_{t-1}^{\mathrm{IND}}$	0.0991***	0.0977***	0.0855***	0.0841***	0.0666***
	[0.108]	[0.107]	[0.0921]	[0.0834]	[0.0638]
	(0.0164)	(0.0162)	(0.0154)	(0.0181)	(0.0158)
Observations	103,453	103,453	93,739	84,257	76,020
R-squared	0.392	0.396	0.397	0.425	0.426
Firm FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standardized beta coefficients in square brackets

Industry-clustered standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7

Data is from CRSP and COMPUSTAT 1981-2013, excluding utilities and financial companies. I_t / K_{t-1} is the investment rate and is defined as the ratio of capital expenditure (item #128) to beginning of period capital stock, constructed with a perpetual inventory method. CF_t / A_{t-1} is the ratio of income before depreciation (item #18 + item #14), to the beginning of period total assets (item #6). $\mathrm{PDEV}_{t-1}^{\mathrm{IND}}$ is the industry price-fundamental deviation at the end of period $t-1$, described in section 3. Bubbly industries refers to six industries whose output prices may contain a bubble component: Oil and Gas Extraction (1), Mining (2), Construction (3), Petroleum and Coal Products (10), Primary Metals (15) and Real Estate (36). Nominal variables are deflated by the CPI and firm level ratios are Windsorized at the 1% and 99% percentiles.

Price Deviation and Investment

	(1)	(2)	(3)	(4)	(5)
	All Industries	All Industries	Excluding Bubbly Goods	All Industries	Excluding Bubbly Goods
	1981-2013	1981-2013	1981-2013	1981-1997 & 2003-2013	1981-1997 & 2003-2013
VARIABLES	I_t / K_{t-1}	I_t / K_{t-1}	I_t / K_{t-1}	I_t / K_{t-1}	I_t / K_{t-1}
CF_t / A_{t-1}		0.165***	0.158***	0.200***	0.190***
		[0.105]	[0.102]	[0.125]	[0.121]
		(0.0258)	(0.0260)	(0.0296)	(0.0295)
$YOUNG_t$	0.151***	0.151***	0.156***	0.155***	0.160***
	[0.205]	[0.206]	[0.211]	[0.215]	[0.223]
	(0.00705)	(0.00706)	(0.00696)	(0.00754)	(0.00735)
$PDEV^{IND}_{t-1}$	0.0703***	0.0672***	0.0553***	0.0617***	0.0439***
	[0.0769]	[0.0736]	[0.0596]	[0.0612]	[0.0421]
	(0.0148)	(0.0142)	(0.0130)	(0.0163)	(0.0135)
$PDEV^{IND}_{t-1} \times YOUNG_t$	0.0768***	0.0828***	0.0809***	0.0551***	0.0498**
	[0.0496]	[0.0534]	[0.0517]	[0.0290]	[0.0250]
	(0.0203)	(0.0211)	(0.0230)	(0.0203)	(0.0236)
Observations	103,453	103,453	93,739	84,257	76,020
R-squared	0.412	0.416	0.418	0.443	0.445
Firm FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standardized beta coefficients in square brackets

Industry-clustered standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 8

Data is from CRSP and COMPUSTAT 1981-2013, excluding utilities and financial companies. I_t / K_{t-1} is the investment rate and is defined as the ratio of capital expenditure (item #128) to beginning of period capital stock, constructed with a perpetual inventory method. CF_t / A_{t-1} is the ratio of income before depreciation (item #18 + item #14), to the beginning of period total assets (item #6). $PDEV^{IND}_{t-1}$ is the industry price-fundamental deviation at the end of period $t-1$, described in section 3. Bubbly industries refers to six industries whose output prices may contain a bubble component: Oil and Gas Extraction (1), Mining (2), Construction (3), Petroleum and Coal Products (10), Primary Metals (15) and Real Estate (36). Nominal variables are deflated by the CPI and firm level ratios are Windsorized at the 1% and 99% percentiles.

Investment Elasticities

	(1)	(2)	(3)	(4)	(5)	(6)
	All Industries	All Industries	All Industries	Excluding Bubbly Goods	All Industries	Excluding Bubbly Goods
	1981-2013	1981-2013	1981-2013	1981-2013	1981-1997 & 2003-2013	1981-1997 & 2003-2013
VARIABLES	i_t	i_t	i_t	i_t	i_t	i_t
$\text{fundamental}^{\text{IND}}_{t-1}$	0.563***		0.191**	0.164	0.218**	0.220*
	(0.0724)		(0.0725)	(0.117)	(0.0841)	(0.119)
$\text{price}^{\text{IND}}_{t-1}$		0.465***	0.393***	0.330***	0.421***	0.298***
		(0.0663)	(0.0654)	(0.0516)	(0.0914)	(0.0531)
$\hat{\alpha} + \hat{\beta}$			0.583***	0.494***	0.639***	0.518***
			(0.0730)	(0.1149)	(0.0885)	(0.1209)
Observations	117,626	117,626	117,626	106,078	96,081	86,229
R-squared	0.850	0.851	0.851	0.851	0.858	0.859
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Industry Trend	YES	YES	YES	YES	YES	YES

Industry-clustered standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 9

Data is from CRSP and COMPUSTAT 1981-2013, excluding utilities and financial companies. i_t is the log of capital expenditures (item #128). $\text{fundamental}^{\text{IND}}_{t-1}$ and $\text{price}^{\text{IND}}_{t-1}$ are the industry fundamental and price at the end of period $t-1$, described in section 3. Bubbly industries refers to six industries whose output prices may contain a bubble component: Oil and Gas Extraction (1), Mining (2), Construction (3), Petroleum and Coal Products (10), Primary Metals (15) and Real Estate (36). Nominal variables are deflated by the CPI.

Investment Elasticities

	(1)	(2)	(3)	(4)	(5)	(6)
	All Industries	All Industries	All Industries	Excluding Bubbly Goods	All Industries	Excluding Bubbly Goods
	1981-2013	1981-2013	1981-2013	1981-2013	1981-1997 & 2003-2013	1981-1997 & 2003-2013
VARIABLES	i_t	i_t	i_t	i_t	i_t	i_t
YOUNG_t	-0.944***	-1.052***	-0.709***	-0.645***	-0.688***	-0.615***
	(0.216)	(0.198)	(0.211)	(0.233)	(0.200)	(0.217)
$\mathrm{fundamental}^{\mathrm{IND}}_{t-1}$	0.553***		0.254***	0.238**	0.250***	0.252*
	(0.0725)		(0.0730)	(0.117)	(0.0895)	(0.125)
$\mathrm{price}^{\mathrm{IND}}_{t-1}$		0.449***	0.329***	0.260***	0.395***	0.272***
		(0.0685)	(0.0694)	(0.0508)	(0.0953)	(0.0558)
$\mathrm{fundamental}^{\mathrm{IND}}_{t-1} \times \mathrm{YOUNG}_t$	0.0742***		-0.198***	-0.216***	-0.104	-0.105
	(0.0188)		(0.0596)	(0.0649)	(0.0714)	(0.0820)
$\mathrm{price}^{\mathrm{IND}}_{t-1} \times \mathrm{YOUNG}_t$		0.0825***	0.249***	0.262***	0.152**	0.146*
		(0.0171)	(0.0516)	(0.0561)	(0.0652)	(0.0759)
$\hat{\alpha} + \hat{\beta}$			0.583***	0.498***	0.644***	0.524***
			(0.0736)	(0.1151)	(0.0900)	(0.1224)
$\hat{\alpha}_{\mathrm{Y}} + \hat{\beta}_{\mathrm{Y}}$			0.0518***	0.0463**	0.0473***	0.0408**
			(0.0183)	(0.0201)	(0.0171)	(0.0184)
Observations	117,626	117,626	117,626	106,078	96,081	86,229
R-squared	0.851	0.851	0.852	0.852	0.859	0.860
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Industry Trend	YES	YES	YES	YES	YES	YES

Industry-clustered standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 10

Data is from CRSP and COMPUSTAT 1981-2013, excluding utilities and financial companies. i_t is the log of capital expenditures (item #128). $\mathrm{fundamental}^{\mathrm{IND}}_{t-1}$ and $\mathrm{price}^{\mathrm{IND}}_{t-1}$ are the industry fundamental and price at the end of period $t-1$, described in section 3. Bubbly industries refers to six industries whose output prices may contain a bubble component: Oil and Gas Extraction (1), Mining (2), Construction (3), Petroleum and Coal Products (10), Primary Metals (15) and Real Estate (36). Nominal variables are deflated by the CPI.

2.15 Tables: Productivity Growth

Price Deviation and TFP Growth

	(1)	(2)	(3)	(4)
	All Industries	Excluding Bubbly Goods	All Industries	Excluding Bubbly Goods
	1981-2013	1981-2013	1981-1997 & 2003-2013	1981-1997 & 2003-2013
VARIABLES	ΔTFP	ΔTFP	ΔTFP	ΔTFP
$\text{PDEV}_{t-1}^{\text{IND}}$	0.0111	0.0144	0.0209	0.0296**
	[0.0141]	[0.0184]	[0.0241]	[0.0335]
	(0.0115)	(0.00978)	(0.0171)	(0.0131)
Observations	99,756	90,528	80,832	73,062
R-squared	0.146	0.149	0.163	0.166
Industry FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Industry-clustered standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 11

Data is from CRSP and COMPUSTAT 1981-2013, excluding utilities and financial companies. $\text{PDEV}_{t-1}^{\text{IND}}$ is the industry price-fundamental deviation at the end of period $t-1$, described in section 3. Bubbly industries refers to six industries whose output prices may contain a bubble component: Oil and Gas Extraction (1), Mining (2), Construction (3), Petroleum and Coal Products (10), Primary Metals (15) and Real Estate (36). Nominal variables are deflated by the CPI and firm level ratios are Windsorized at the 1% and 99% percentiles.

Price Deviation and TFP Growth				
	(1)	(2)	(3)	(4)
	All Industries	Excluding Bubbly Goods	All Industries	Excluding Bubbly Goods
	1981-2013	1981-2013	1981-1997 & 2003-2013	1981-1997 & 2003-2013
VARIABLES	ΔTFP	ΔTFP	ΔTFP	ΔTFP
YOUNG$_t$	0.0130**	0.0115*	0.0102*	0.00876
	[0.0197]	[0.0177]	[0.0158]	[0.0140]
	(0.00598)	(0.00643)	(0.00594)	(0.00651)
PDEV$^{\text{IND}}_{t-1}$	0.0160	0.0182*	0.0281	0.0340**
	[0.0204]	[0.0232]	[0.0324]	[0.0392]
	(0.0115)	(0.0105)	(0.0168)	(0.0141)
PDEV$^{\text{IND}}_{t-1}$ $\times$ YOUNG$_t$	-0.0268**	-0.0200	-0.0485***	-0.0397***
	[-0.0186]	[-0.0141]	[-0.0272]	[-0.0221]
	(0.0127)	(0.0133)	(0.0149)	(0.0145)
Observations	99,756	90,528	80,832	72,651
R-squared	0.147	0.150	0.163	0.169
Industry FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Industry-clustered standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 12

Data is from CRSP and COMPUSTAT 1981-2013, excluding utilities and financial companies. PDEV$^{\text{IND}}_{t-1}$ is the industry price-fundamental deviation at the end of period $t-1$, described in section 3. Bubbly industries refers to six industries whose output prices may contain a bubble component: Oil and Gas Extraction (1), Mining (2), Construction (3), Petroleum and Coal Products (10), Primary Metals (15) and Real Estate (36). Nominal variables are deflated by the CPI and firm level ratios are Windsorized at the 1% and 99% percentiles.

2.16 Tables: Other Variables

Price Deviation and Employment

	(1)	(2)	(3)	(4)	(5)
	All Industries	All Industries	Excluding Bubbly Goods	All Industries	Excluding Bubbly Goods
	1981-2013	1981-2013	1981-2013	1981-1997 & 2003-2013	1981-1997 & 2003-2013
VARIABLES	Δ EMP$_t$ / EMP$_{t-1}$	Δ EMP$_t$ / EMP$_{t-1}$	Δ EMP$_t$ / EMP$_{t-1}$	Δ EMP$_t$ / EMP$_{t-1}$	Δ EMP$_t$ / EMP$_{t-1}$
CF$_t$ / A$_{t-1}$		0.254***	0.243***	0.298***	0.284***
		[0.146]	[0.144]	[0.167]	[0.164]
		(0.0743)	(0.0770)	(0.0811)	(0.0846)
PDEV$_{t-1}^{\text{IND}}$	0.0824***	0.0802***	0.0707***	0.0758***	0.0609***
	[0.0817]	[0.0796]	[0.0698]	[0.0673]	[0.0527]
	(0.0149)	(0.0146)	(0.0144)	(0.0194)	(0.0194)
Observations	103,453	103,453	93,739	84,257	76,020
R-squared	0.215	0.223	0.226	0.252	0.254
Firm FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standardized beta coefficients in square brackets

Industry-clustered standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 13

Data is from CRSP and COMPUSTAT 1981-2013, excluding utilities and financial companies. Δ EMP$_t$ / EMP$_{t-1}$ is the growth rate of the number of employees (item #29). CF$_t$ / A$_{t-1}$ is the ratio of income before depreciation (item #18 + item #14), to the beginning of period total assets (item #6). PDEV$_{t-1}^{\text{IND}}$ is the industry price-fundamental deviation at the end of period $t-1$, described in section 3. Bubbly industries refers to six industries whose output prices may contain a bubble component: Oil and Gas Extraction (1), Mining (2), Construction (3), Petroleum and Coal Products (10), Primary Metals (15) and Real Estate (36). Nominal variables are deflated by the CPI and firm level ratios are Windsorized at the 1% and 99% percentiles.

Price Deviation and Long Term Debt Issuance

	(1)	(2)	(3)	(4)	(5)
	All Industries	All Industries	Excluding Bubbly Goods	All Industries	Excluding Bubbly Goods
	1981-2013	1981-2013	1981-2013	1981-1997 & 2003-2013	1981-1997 & 2003-2013
VARIABLES	Δ LD$_t$/A$_{t-1}$	Δ LD$_t$/A$_{t-1}$	Δ LD$_t$/A$_{t-1}$	Δ LD$_t$/A$_{t-1}$	Δ LD$_t$/A$_{t-1}$
CF$_t$ / A$_{t-1}$		-0.0175	-0.0218*	-0.00819	-0.0169
		[-0.0263]	[-0.0341]	[-0.0118]	[-0.0253]
		(0.0116)	(0.0113)	(0.0133)	(0.0119)
PDEV$^{\text{IND}}_{t-1}$	0.0238***	0.0239***	0.0176***	0.0286***	0.0205***
	[0.0618]	[0.0622]	[0.0460]	[0.0656]	[0.0461]
	(0.00551)	(0.00559)	(0.00449)	(0.00693)	(0.00570)
Observations	103,453	103,453	93,739	84,257	76,020
R-squared	0.207	0.207	0.203	0.239	0.235
Firm FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standardized beta coefficients in square brackets
Industry-clustered standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 14

Data is from CRSP and COMPUSTAT 1981-2013, excluding utilities and financial companies. Δ LD$_t$/A$_{t-1}$ is the ratio of net long term debt issue (item #111 - item #114) to the beginning of the period total assets (item #6). CF$_t$ / A$_{t-1}$ is the ratio of income before depreciation (item #18 + item #14), to the beginning of period total assets (item #6). PDEV$^{\text{IND}}_{t-1}$ is the industry price-fundamental deviation at the end of period $t-1$, described in section 3. Bubbly industries refers to six industries whose output prices may contain a bubble component: Oil and Gas Extraction (1), Mining (2), Construction (3), Petroleum and Coal Products (10), Primary Metals (15) and Real Estate (36). Nominal variables are deflated by the CPI and firm level ratios are Windsorized at the 1% and 99% percentiles.

Price Deviation and Total Payout					
	(1)	(2)	(3)	(4)	(5)
	All Industries	All Industries	Excluding Bubbly Goods	All Industries	Excluding Bubbly Goods
	1981-2013	1981-2013	1981-2013	1981-1997 & 2003-2013	1981-1997 & 2003-2013
VARIABLES	PAY$_t$ / A$_{t-1}$	PAY$_t$ / A$_{t-1}$	PAY$_t$ / A$_{t-1}$	PAY$_t$ / A$_{t-1}$	PAY$_t$ / A$_{t-1}$
CF$_t$ / A$_{t-1}$		0.320***	0.330***	0.298***	0.311***
		[0.267]	[0.276]	[0.244]	[0.255]
		(0.0960)	(0.101)	(0.107)	(0.112)
PDEV$_{t-1}^{\text{IND}}$	-0.0282***	-0.0308***	-0.0286***	-0.0325**	-0.0316**
	[-0.0406]	[-0.0444]	[-0.0399]	[-0.0422]	[-0.0390]
	(0.00639)	(0.00587)	(0.00675)	(0.0121)	(0.0130)
Observations	103,202	103,202	93,526	84,053	75,847
R-squared	0.345	0.373	0.378	0.402	0.409
Firm FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standardized beta coefficients in square brackets
Industry-clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 15

Data is from CRSP and COMPUSTAT 1981-2013, excluding utilities and financial companies. PAY$_t$ / A$_{t-1}$ is the payout ratio, defined as the sum of common dividends (item #21) and net stock repurchases (item #115 - item #108 - Δ item #56), divided by the beginning of the period total assets (item #6). CF$_t$ / A$_{t-1}$ is the ratio of income before depreciation (item #18 + item #14), to the beginning of period total assets (item #6). PDEV$_{t-1}^{\text{IND}}$ is the industry price-fundamental deviation at the end of period $t-1$, described in section 3. Bubbly industries refers to six industries whose output prices may contain a bubble component: Oil and Gas Extraction (1), Mining (2), Construction (3), Petroleum and Coal Products (10), Primary Metals (15) and Real Estate (36). Nominal variables are deflated by the CPI and firm level ratios are Windsorized at the 1% and 99% percentiles.

Price Deviation and Equity Issuance

	(1)	(2)	(3)	(4)	(5)
	All Industries	All Industries	Excluding Bubbly Goods	All Industries	Excluding Bubbly Goods
	1981-2013	1981-2013	1981-2013	1981-1997 & 2003-2013	1981-1997 & 2003-2013
VARIABLES	$\mathbb{1}_t^{\text{ISS}}$	$\mathbb{1}_t^{\text{ISS}}$	$\mathbb{1}_t^{\text{ISS}}$	$\mathbb{1}_t^{\text{ISS}}$	$\mathbb{1}_t^{\text{ISS}}$
CF_t / A_{t-1}		-0.0112	-0.0186	0.0133	0.00479
		[-0.00481]	[-0.00820]	[0.00546]	[0.00201]
		(0.0292)	(0.0296)	(0.0349)	(0.0355)
$\text{PDEV}_{t-1}^{\text{IND}}$	0.0702***	0.0703***	0.0709***	0.0497***	0.0461**
	[0.0523]	[0.0523]	[0.0520]	[0.0324]	[0.0290]
	(0.0153)	(0.0152)	(0.0173)	(0.0182)	(0.0213)
Observations	103,202	103,202	93,526	84,053	75,847
R-squared	0.448	0.448	0.453	0.465	0.470
Firm FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standardized beta coefficients in square brackets

Industry-clustered standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 16

Data is from CRSP and COMPUSTAT 1981-2013, excluding utilities and financial companies. 1_t^{ISS} is a binary variable that takes value 1 if total payout is negative (and zero otherwise). Total payout is defined as the sum of common dividends (item #21) and net stock repurchases (item #115 - item #108 - Δ item #56). CF_t / A_{t-1} is the ratio of income before depreciation (item #18 + item #14), to the beginning of period total assets (item #6). $\text{PDEV}_{t-1}^{\text{IND}}$ is the industry price-fundamental deviation at the end of period $t-1$, described in section 3. Bubbly industries refers to six industries whose output prices may contain a bubble component: Oil and Gas Extraction (1), Mining (2), Construction (3), Petroleum and Coal Products (10), Primary Metals (15) and Real Estate (36). Nominal variables are deflated by the CPI and firm level ratios are Windsorized at the 1% and 99% percentiles.

Price Deviation and Leverage

	(1)	(2)	(3)	(4)	(5)
	All Industries	All Industries	Excluding Bubbly Goods	All Industries	Excluding Bubbly Goods
	1981-2013	1981-2013	1981-2013	1981-1997 & 2003-2013	1981-1997 & 2003-2013
VARIABLES	LEV_t	LEV_t	LEV_t	LEV_t	LEV_t
CF_t / A_{t-1}		-0.321***	-0.314***	-0.344***	-0.338***
		[-0.216]	[-0.215]	[-0.222]	[-0.223]
		(0.0397)	(0.0412)	(0.0516)	(0.0546)
$\text{PDEV}^{\text{IND}}_{t-1}$	-0.0380***	-0.0352***	-0.0384***	-0.0307***	-0.0358***
	[-0.0441]	[-0.0409]	[-0.0439]	[-0.0315]	[-0.0355]
	(0.00909)	(0.00876)	(0.00941)	(0.00999)	(0.0115)
Observations	103,088	103,088	93,451	83,965	75,790
R-squared	0.593	0.611	0.613	0.627	0.629
Firm FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standardized beta coefficients in square brackets

Industry-clustered standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 17

Data is from CRSP and COMPUSTAT 1981-2013, excluding utilities and financial companies. LEV_t is the leverage ratio, constructed as debt (item #9 + item #34) divided by debt plus the book value of equity (item #9 + item #34 + item #216). CF_t / A_{t-1} is the ratio of income before depreciation (item #18 + item #14), to the beginning of period total assets (item #6). $\text{PDEV}^{\text{IND}}_{t-1}$ is the industry price-fundamental deviation at the end of period $t-1$, described in section 3. Bubbly industries refers to six industries whose output prices may contain a bubble component: Oil and Gas Extraction (1), Mining (2), Construction (3), Petroleum and Coal Products (10), Primary Metals (15) and Real Estate (36). Nominal variables are deflated by the CPI and firm level ratios are Windsorized at the 1% and 99% percentiles.

2.17 Tables: Entrants' TFP

Entry and Productivity					
	(1)	(2)	(3)	(4)	(5)
	Year 1	Year 2	Year 3	Year 4	Year 5
VARIABLES	TFP	TFP	TFP	TFP	TFP
$\text{PDEV}_{t-1}^{\text{IND}}$	-0.290*** [-0.0917] (0.0973)				
$\text{PDEV}_{t-2}^{\text{IND}}$		-0.295*** [-0.0986] (0.0976)			
$\text{PDEV}_{t-3}^{\text{IND}}$			-0.251*** [-0.0855] (0.0902)		
$\text{PDEV}_{t-4}^{\text{IND}}$				-0.205* [-0.0705] (0.103)	
$\text{PDEV}_{t-5}^{\text{IND}}$					-0.234** [-0.0811] (0.108)
Observations	8,147	7,772	6,980	6,206	5,555
R-squared	0.441	0.464	0.483	0.525	0.547
Industry FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Time Trend	YES	YES	YES	YES	YES

Standardized beta coefficients in square brackets
Industry-clustered standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 18

Data is from CRSP and COMPUSTAT 1980-2013, excluding utilities and financial companies. Variables are constructed with industry-aggregated data. Nominal variables are deflated by the CPI and firm level ratios are Windsorized at the 1% and 99% percentiles.

Price Deviation and TFP of Incumbents				
	(1)	(2)	(3)	(4)
	All Industries	Excluding Bubbly Goods	All Industries	Excluding Bubbly Goods
	1981-2013	1981-2013	1981-1997 & 2003-2013	1981-1997 & 2003-2013
VARIABLES	TFP	TFP	TFP	TFP
$\text{PDEV}_{t-1}^{\text{IND}}$	0.0498*	0.0642**	0.0371	0.0499*
	[0.0174]	[0.0217]	[0.0118]	[0.0151]
	(0.0272)	(0.0289)	(0.0258)	(0.0279)
Observations	72,118	65,125	60,065	54,163
R-squared	0.905	0.914	0.911	0.920
Industry FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Industry Trend	YES	YES	YES	YES

Industry-clustered standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 19

Data is from CRSP and COMPUSTAT 1981-2013, excluding utilities and financial companies. $\text{PDEV}_{t-1}^{\text{IND}}$ is the industry price-fundamental deviation at the end of period $t-1$, described in section 3. Bubbly industries refers to six industries whose output prices may contain a bubble component: Oil and Gas Extraction (1), Mining (2), Construction (3), Petroleum and Coal Products (10), Primary Metals (15) and Real Estate (36). Nominal variables are deflated by the CPI and firm level ratios are Windsorized at the 1% and 99% percentiles.

Price Deviation and TFP of Incumbents

	(1)	(2)	(3)	(4)
	All Industries	Excluding Bubbly Goods	All Industries	Excluding Bubbly Goods
	1981-2013	1981-2013	1981-1997 & 2003-2013	1981-1997 & 2003-2013
VARIABLES	TFP	TFP	TFP	TFP
$\text{PDEV}^{\text{IND}}_{t-1}$	0.0747**	0.0812**	0.0743***	0.0746***
	[0.0238]	[0.0249]	[0.0213]	[0.0201]
	(0.0283)	(0.0315)	(0.0235)	(0.0262)
$\text{PDEV}^{\text{IND}}_{t-2}$	0.00101	-0.00884	0.00304	-0.00643
	[0.000334]	[-0.00280]	[0.000917]	[-0.00183]
	(0.0132)	(0.00999)	(0.0167)	(0.0151)
$\text{PDEV}^{\text{IND}}_{t-3}$	-0.0254	-0.0178	-0.0188	-0.0197
	[-0.00874]	[-0.00591]	[-0.00623]	[-0.00621]
	(0.0166)	(0.0178)	(0.0293)	(0.0329)
$\text{PDEV}^{\text{IND}}_{t-4}$	0.0134	0.00863	0.0115	0.00890
	[0.00474]	[0.00295]	[0.00420]	[0.00312]
	(0.0105)	(0.0122)	(0.0169)	(0.0190)
$\text{PDEV}^{\text{IND}}_{t-5}$	-0.0308	-0.0271	-0.0345	-0.0261
	[-0.0112]	[-0.00957]	[-0.0133]	[-0.00974]
	(0.0226)	(0.0236)	(0.0225)	(0.0228)
Observations	66,391	60,081	54,338	49,119
R-squared	0.910	0.918	0.917	0.925
Industry FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Industry Trend	YES	YES	YES	YES

Industry-clustered standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 20

Data is from CRSP and COMPUSTAT 1981-2013, excluding utilities and financial companies. $\text{PDEV}^{\text{IND}}_{t-1}$ is the industry price-fundamental deviation at the end of period $t-1$, described in section 3. Bubbly industries refers to six industries whose output prices may contain a bubble component: Oil and Gas Extraction (1), Mining (2), Construction (3), Petroleum and Coal Products (10), Primary Metals (15) and Real Estate (36). Nominal variables are deflated by the CPI and firm level ratios are Windsorized at the 1% and 99% percentiles.

Entry and Productivity					
	(1)	(2)	(3)	(4)	(5)
	Year 1	Year 2	Year 3	Year 4	Year 5
VARIABLES	TFP $^{\text{gap,50}}$	TFP $^{\text{gap,50}}$	TFP $^{\text{gap,50}}$	TFP $^{\text{gap,50}}$	TFP $^{\text{gap,50}}$
PDEV$^{\text{IND}}_{t-1}$	-0.249***				
	[-0.100]				
	(0.0705)				
PDEV$^{\text{IND}}_{t-2}$		-0.222***			
		[-0.0976]			
		(0.0643)			
PDEV$^{\text{IND}}_{t-3}$			-0.158**		
			[-0.0722]		
			(0.0635)		
PDEV$^{\text{IND}}_{t-4}$				-0.130*	
				[-0.0626]	
				(0.0651)	
PDEV$^{\text{IND}}_{t-5}$					-0.165**
					[-0.0820]
					(0.0717)
Observations	8,147	7,772	6,980	6,206	5,555
R-squared	0.120	0.115	0.105	0.096	0.094
Industry FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Standardized beta coefficients in square brackets
Industry-clustered standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 21

Data is from CRSP and COMPUSTAT 1980-2013, excluding utilities and financial companies.

2.18 Tables: IPO Equity Issuance

	IPO Equity Issuance					
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	$\text{EQ\_ISS}^1_t/\text{CINV}^5_t$	$\text{EQ\_ISS}^1_t/\text{CINV}^{10}_t$	$\text{EQ\_ISS}^1_t/\text{CINV}^{15}_t$	$\text{EQ\_ISS}^5_t/\text{CINV}^5_t$	$\text{EQ\_ISS}^5_t/\text{CINV}^{10}_t$	$\text{EQ\_ISS}^5_t/\text{CINV}^{15}_t$
$\text{PDEV}^{\text{IND}}_{t-1}$	1.005***	0.638***	0.250***	1.276**	0.991***	0.456**
	[0.112]	[0.183]	[0.121]	[0.0711]	[0.157]	[0.104]
	(0.269)	(0.107)	(0.0777)	(0.517)	(0.217)	(0.196)
Observations	4,788	2,478	1,389	4,788	2,478	1,389
R-squared	0.184	0.233	0.181	0.220	0.272	0.201
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Standardized beta coefficients in square brackets
Industry-clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 22

Data is from CRSP and COMPUSTAT 1980-2013, excluding utilities and financial companies.

	IPO Long Term Debt Issuance					
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	$\text{LD\_ISS}^1_t/\text{CINV}^5_t$	$\text{LD\_ISS}^1_t/\text{CINV}^{10}_t$	$\text{LD\_ISS}^1_t/\text{CINV}^{15}_t$	$\text{LD\_ISS}^5_t/\text{CINV}^5_t$	$\text{LD\_ISS}^5_t/\text{CINV}^{10}_t$	$\text{LD\_ISS}^5_t/\text{CINV}^{15}_t$
$\text{PDEV}^{\text{IND}}_{t-1}$	-0.00172	-0.00500	0.00684	0.0202	-0.0344	-0.0276
	[-0.000987]	[-0.00761]	[0.0168]	[0.00364]	[-0.0181]	[-0.0234]
	(0.0602)	(0.0249)	(0.0178)	(0.181)	(0.0811)	(0.0785)
Observations	4,788	2,478	1,389	4,788	2,478	1,389
R-squared	0.046	0.046	0.060	0.075	0.071	0.104
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Standardized beta coefficients in square brackets
Industry-clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 23

Data is from CRSP and COMPUSTAT 1980-2013, excluding utilities and financial companies.

Chapter 3

UNDERSTANDING THE RECENT TRENDS IN BUSINESS DYNAMISM: EVIDENCE FROM SPAIN (1995-2007)

Joint with Enrique Moral-Benito

3.1 Introduction

There is a recent and growing literature documenting a secular decline in measures of resource reallocation or business dynamism in the US economy over the last four decades: declining rates of firm entry and exit, of job creation and destruction and an increasing concentration of economic activity in older and larger firms have all been documented. For example, between 1980 and 2007 the US firm entry or startup rate declined from 12.5% to 10.0% and the employment share of firms with 5 or less years declined from 20.8% to 14.0%.[1] These observations have raised concern among policymakers and academic economists. For instance, young firms are known to be an important source of job creation: firms with 5 or less years were responsible for 40% of total gross job creation in the US during

---

[1] See Figure 3.18 in appendix 3.6.

the 1980s (startups alone represented roughly 20% of aggregate gross job creation during that time).[2] Lower rates of firm entry might thus translate into reduced creation of new jobs.[3] Furthermore, the dynamics of entry and exit is known to be an important source of productivity growth.[4] Lower rates of business dynamism could in this regard reflect increasing barriers to resource reallocation across firms, which would ultimately hinder productivity growth.

In spite of ample and growing evidence for the US, there has been little work documenting trends in business dynamism in other countries.[5] Studying the evolution of business dynamism in other economies is however crucial to know whether such trends are particular to the US growth experience, or are instead part of a more generalized phenomenon that is common to other economies. It will also help us assess the validity of different theories. For instance, some of the explanations for the fall in the US startup rate are based on demographic changes such as the deceleration in population growth (Karahan, Pugsley and Şahin (2016)) or the aging of the labor force (Engbom (2017)). If demographics is in fact a key determinant of business dynamism, countries experiencing different demographic trends should not exhibit a decline in indicators of business dynamism.

In this paper we document trends in business dynamism in Spain between 1995 and 2007. The reason we focus on Spain is twofold. First, the Spanish growth experience between 1995 and 2007 has a number of appealing features that make it an interesting setting for the study of business dynamism. First, it experienced a persistent boom over the period considered. A possible decline in indicators of business dynamism cannot be therefore attributed to the existence of

---

[2] See Figure 3.19 in appendix 3.6.

[3] Persistently lower rates of firm entry (which have already been referred to as the *startup deficit*) have already been associated to the existence of *jobless recoveries* (see Pugsley and Şahin (2015)).

[4] Using a sample of eleven manufacturing products, Foster, Haltiwanger and Syverson (2008) find that the dynamics of establishment entry and exit account for one quarter of total industry aggregate productivity growth.

[5] In a recent study, Calvino, Criscuolo and Menon (2015) provide evidence on the evolution of startup rates in a group of fifteen advanced and emerging economies over the 2000-2011 period. At least seven countries in their sample exhibit clear trends of declining startup rates before 2008 (i.e. prior to the financial crisis). Bijnens and Konings (2017) also document a decline in indicators of business dynamism for Belgium over the period 1985-2014.

a recession. Second, it exhibits important differences with respect to the US, such as an acceleration in population growth or a decline in measures of market power. Based upon these differences, we will discuss some of the explanations that are often considered in the literature, which relate the fall in business dynamism in the US to secular demographic trends or an increase in entry barriers.

Second, and most importantly, we have access to a longitudinal panel from the Bank of Spain containing detailed balance sheet data for virtually all Spanish firms. This dataset provides us with unique firm-level information that is not available for the universe of US firms. This way we will be able to look at a number of variables or indicators that are not available in the case of the US. Among other things, we will be looking at the characteristics of young firms (such as total factor productivity) and document how they have evolved with respect to incumbents of the same industry.

To give a preview of our main findings, we document a large and persistent decline in the Spanish firm entry and exit rates over the period considered. For example, the startup rate declined from 12.3% to 5.9% (i.e. by 6.4 percentage points) between 1996 and 2007, whereas the exit rate decreased from 4.9% to 3.9% (i.e. by 1 percentage point). These magnitudes are large if we take into account that over the same period the US firm entry rate declined from 11.2% to 10.1% (i.e. by 1.1 percentage points), whereas the firm exit rate declined from 8.4% to 8.3% (i.e. by 0.1 percentage points). They are also surprising given that in 1996 Spain was starting a period of robust economic growth, which was the longest in its recent history.

We also use our dataset to describe how entrants' characteristics have evolved over time. For instance, we show that the employment size distribution of startups did not change significantly over the period considered. However, when compared to incumbents of the same industry, entrants have become relatively more productive.

But what explains these trends? What is behind the fall in the Spanish firm entry and exit rates? We argue some of the theories that have been put forward to explain the US experience (which in broad terms relate the decline in business dynamism to demographic changes or to increased entry barriers) are unlikely to apply to Spain. For example, we document an acceleration in population growth during the period we consider. Lower rates of population growth do not therefore seem to be the key driver of the fall in dynamism in Spain. Furthermore, we argue that the Spanish growth experience during this period was characterized by a decline in market power, which seems to discard the possibility of increased barriers to entry.

We then consider an alternative explanation and relate the fall in dynamism in Spain to the interest rate decline that has been observed during this period. Associated with the process of the euro convergence, Spain experienced a substantial decline in real interest rates between 1995 and 2007. This is a major shock affecting the Spanish economy over this period, whose implications have also been studied in different context.[6]

There are two main facts that we want to explain: (i) why entry and exit rates have declined and (ii) why entrants have become relatively more productive over time. We show that both facts may be associated with the decline in real interest rates experienced by Spain over this period.

To this end, we build a small open economy model based on the framework of Melitz (2003). Firms use capital as an input of production and can borrow at an exogenously given world interest rate. They have to pay a fixed production cost and their idiosyncratic productivity follows a simple Markov process. As in standard models of firm dynamics, our economy is characterized by a productivity cutoff level below which firms do not find it profitable to produce. Upon making a low productivity draw, firms will therefore decide to exit to avoid paying their fixed production costs. Exiting firms are replaced by new firms, which need to pay a sunk cost upon entry. Firms may however be subject to a credit constraint, that limits' their borrowing and investment capacity. Importantly, credit constraints are more prevalent across young firms.

We first study the implications of an interest rate decline for the rates of firm entry and exit. We show that, even when financial frictions are absent, a lower interest rate may be associated with lower rates of firm entry and exit. This happens because a decline in interest rates, by reducing operation costs, may be associated with a lower productivity cutoff required for firms to break even. This means that

---

[6] Gopinath et al. (2017) study the impact of the interest rate decline for misallocation in Spain.

firms will be less likely to exit upon making a new productivity draw, so that survival probabilities increase. In a stationary equilibrium, this fact translates into lower turnover and hence lower entry and exit rates.

When financial markets are perfect, there is however no fundamental distinction between incumbents and entrants in our model. This benchmark version of the model cannot therefore explain one fact that we observe in our dataset, namely that young firms have become more productive relative to incumbents. To explain this fact we introduce financial frictions. We show that when credit constraints are present, incumbents (which in our model are mainly unconstrained) tend to benefit more from lower interest rates: conditional on productivity, they can increase borrowing and hence capital disproportionately more. As a result, their exit productivity cutoff declines at a faster rate. In other words, young firms (which are predominantly constrained) will have a relatively lower capital stock and will need to be on average more productivity to survive. At the heart of our model is the idea that a decline in interest rates will benefit disproportionately more larger or unconstrained firms.[7]

3.1.1 Related Literature

Our paper is related to three strands of the literature. First, it is related to the recent and expanding literature studying the evolution of business dynamism in the US. Decker et al. (2014b) and Haltiwanger (2015) provide a comprehensive overview recent trends in indicators of business dynamism in the US. Among other facts, they document a significant decline in the rates of firm entry and exit and an increasing concentration of employment in older and larger firms. Pugsley and Şahin (2015) show that, in spite of the fall in the startup rate, the lifecycle dynamics of firms has remained virtually unchanged. Decker et al. (2017) argue that the decline in dynamism is not associated with a decrease in the volatility of firm-level productivity shocks, but rather with a weaker response to those shocks.

Some authors have discussed possible causes behind the decline in business dynamism. Karahan, Pugsley and Şahin (2016) link the decline in the US startup rate to the deceleration in population growth. Engbom (2017) relates the decline in

---

[7] Such finding is consistent with the results of Gopinath et al. (2017).

business dynamism to the aging of the US labor market. Goldschlag and Tabarrok (2018) ask whether the fall in dynamism can be linked to an increase in industry regulation. They find no significant association between changes in indicators of business dynamism and changes in regulation at the the industry level.

Second, our paper is related to a vast literature on firm dynamics, which includes the seminal work of Hopenhayn (1992) and the more recent contributions of Melitz (2003), Carvalho and Grassi (2015) and Clementi and Palazzo (2016). Our model builds upon the framework of Melitz (2003), though there are some differences. In particular, we study a small open economy where firms use capital as an input in production. Furthermore, we introduce financial frictions. Our paper is therefore closely connected to the literature studying the implication of financial frictions for firm dynamics, which includes the work of Cooley and Quadrini (2001), Clementi and Hopenhayn (2006) and Caggese and Cuñat (2013).

Finally, this paper speaks to the literature studying the Spanish economic boom between 1995-2007, and in particular its aggregate productivity slowdown. García-Santana et al. (2016) relate the aggregate TFP slowdown in Spain to an increase in factor misallocation across firms. They show that the increase in misallocation has been particularly severe in sectors that are more prone to cronyism. Gopinath et al. (2017) also document an increase in factor misallocation and relate it to the decline in real interest rates experienced by Spain. Finally, Tang (2017) argues that the emergence of an asset bubble may explain the fall of aggregate TFP in Spain.

3.1.2 Some Facts about Spain

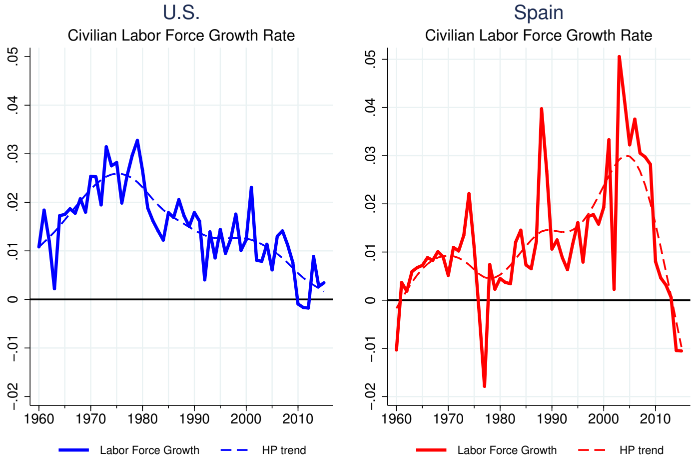
Between 1994 and 2007, Spain experienced a period of fast economic growth. GDP grew at an average rate of 3.5% per year (compared to a EU average of 2.2% over the same period). Most of this growth was associated with increased factor accumulation, and not by TFP growth. Indeed, Spain experienced negative TFP growth over this period.

We next present some aspects of the Spanish growth experience and compare them to the US. We will argue that Spain and the US differed along important dimensions. In particular, some trends that have been documented for the US -

and used to explain the decline in business dynamism - are not observed in Spain. Building upon these differences, we conclude that there must be a different force behind the decline in business dynamism in Spain.

Demographic Trends

Some authors have related the fall in indicators of business dynamism in the US to secular demographic trends. For instance, Karahan, Pugsley and Şahin (2016) link the decline in the US startup rate to the deceleration in population growth (left panel of Figure 3.1). The argument is straightforward: economies whose labor force starts growing at slower rates should experience lower rates of new firm creation. The authors construct a general equilibrium version of the Hopenhayn (1992) model with population growth to make their point.[8] Could a similar argument be applied to Spain? The right panel of Figure 3.1 shows the growth rate of the Spanish civilian labor force (between 1980 and 2015). It is evident that population growth accelerates between 1980 and 2007 (and particularly after 1995, during the period we study). Therefore, changes in the rate of total population growth do not seem likely to be a major driver of the fall in dynamism in Spain.



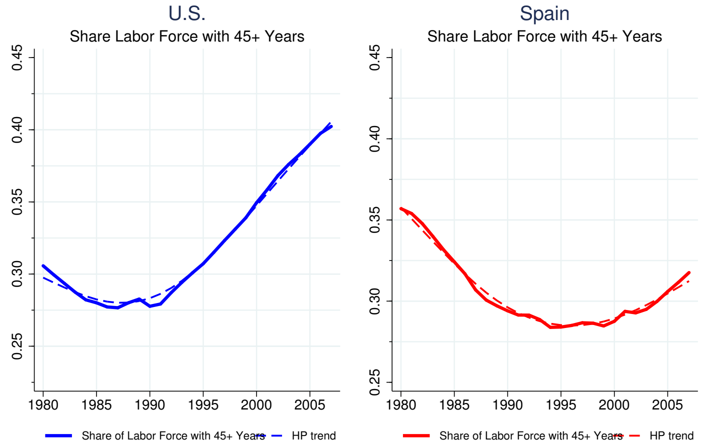
Source: OECD

Figure 3.1: Population Growth Rates: US versus Spain

---

[8] They also exploit cross-sectional demographic variation to show that the startup rate tends to respond positively to labor supply growth.

The fall in US business dynamism has been also related to other demographic trends, namely the aging of the labor force. For instance, Engbom (2017) notes that an aged labor force may be associated with lower levels of business dynamism through two main channels. On the one hand old individuals tend to be less likely to be entrepreneurs. On the other hand, by having had more time to find a good match for their skills, they are less likely to move across employers. The left panel of Figure 3.2 shows the share of the US civilian labor force with 45 or more years (between 1980 and 2007). This has increased from 31% to 40% over the period considered, which represents a substantial compositional change. This contrasts with the Spanish experience (right panel). Between 1980 and 2007, the share of the Spanish civilian labor force with 45 or more years experiences a small decline (from 36% to 32%). Note that there is a 3.3 percentage increase during the period considered (it increases from 28.4% 1995 to 31.7% in 2007). However, this jump is significantly smaller than the 9.5 percentage increase observed for the US during the same period (it went from 30.7% in 1995 to 40.2% in 2007). Furthermore, as we will see in section 3.2.2, Spain displays a much larger decline in indicators of business dynamism. Therefore, we think that although population aging can be on factor contributing for lower business dynamism in Spain, it is unlikely to be the main driver.



Source: OECD
Share of labor force between 20–64 years with 45 or more years

Figure 3.2: Population Aging: US versus Spain

Market Power

Another set of explanations for the decline in US business dynamism is based on increased entry barriers, which could for example stem from increased labor market regulations. For instance, Davis and Haltiwanger (2014) argue that increased protection of American workers has been associated with lower rates of dynamism. They exploit cross-state variation in the timing of exceptions to the so called *employment-at-will* doctrine to show that these have been associated with lower rates of job reallocation.[9] Increased barriers to entry might also be associated with the appearance of new technologies. For example, there may be technological developments that favor the existence of natural monopolies or larger businesses in general. As argued by Foster, Haltiwanger and Krizan (2006), the ICT revolution was behind a major transformation of the retail sector during the 1990s, with activity being increasingly concentrated in larger firms.

Overall, the idea of increased entry barriers is supported by a variety of signs that suggest a generalized increase in market power in the US economy since the 1980s: increasing industry concentration (Autor et al. (2017)), increasing price-cost markups (Eeckhout and De Loecker (2017)) and a lower firm-level responsiveness to TFP shocks (Decker et al. (2017)) have all been documented.

However, the Spanish growth experience between 1995-2007 does not seem consistent with the idea of rising market power. First, price-cost markups have been significantly stable over the period (Montero and Urtasun (2014)). Second, an analysis of our firm-level dataset suggests a generalized decrease in indicators of industry concentration. For instance, we use our dataset to construct the shares of the 4, 10 and 20 largest firms within each 4-digit industry (both in terms of revenues and employment). Figure 3.3 plots a weighted average of such ratios (see appendix 3.10 for details). The left panel reports the results for revenues (or output), whereas the right panel focuses on employment. Figure 3.3 suggests that concentration has declined over the period considered. The results for the 1995-2000 period should be interpreted with caution, since coverage of our dataset in-

---

[9] According to Davis and Haltiwanger (2014): "These exceptions emerged in precedent-setting decisions by state courts from 1972 to 1999, and proliferated rapidly in the 1980s, seriously eroding the presumption that employees could be fired at will."

creases during these years (as explained in appendix 3.5). However, even when focusing on the 2001-2007 period (when coverage is stable) we do observe a decline in concentration. Between 2001 and 2007, the weighted-average market share of the 4 largest firms falls from 33.2% to 31.9%, whereas the share of the 20 largest firms experiences a decline from 52.9% to 50.8%. When looking at employment, there is a similar trend: the share of the 4 largest firms declines from 26.5% to 25.8%, and the share of the 20 largest firms falls from 44.1% to 42.2%.

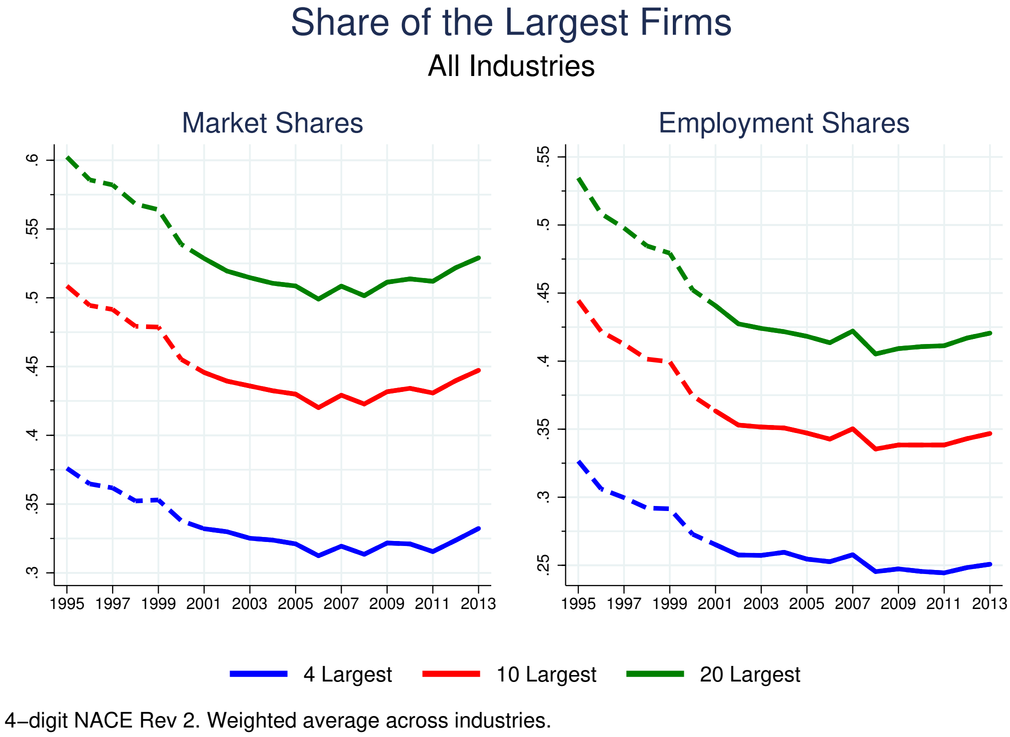


Figure 3.3: Shares of the Largest Firms at the Industry Level

Given all this evidence, we think the Spanish growth experience between 1995 and 2007 has not been characterized by an increase in market power. We therefore think that entry barriers are unlikely to be a major force behind the fall in business dynamism in Spain.

The rest of the paper is organized as follows. Section 3.2 describes our dataset and the main empirical facts. Section 3.3 presents the model. Section 3.4 concludes.

3.2 Empirical Facts

3.2.1 Data Description

DIRCE This paper uses two firm-level datasets. The first one is the Central Business Register (*Directorio Central de Empresas*, DIRCE) constructed by the Spanish Statistical Office. This is a firm-level administrative dataset containing the yearly record of all firm births (*altas*) and deaths (*bajas*), from 1995 to 2013. It includes both limited liability companies (*Sociedades de Responsabilidad Limitada*) and public limited companies (*Sociedades Anónimas*), but excludes physical persons and firms created under alternative legal forms. Besides indicating whether a firm (identified by its tax number) corresponds to a birth or a death, the dataset also contains information on its number of employees and industry classification (at the 4-digit level). Given that it covers the entire universe of entry and exit, this dataset allows us to construct exact numbers for firm entry and exit rates, as well as for job creation and destruction rates due to firm births and deaths (both at the national and at the industry level).

Two caveats should however be mentioned. The first is that DIRCE treats as births (deaths) the reactivations (deactivations) of firms. Therefore, the same firm can be classified as a birth or a death multiple times in the sample period 1995-2013. Since we want to focus on actual firm entry and exit (as opposed to reactivations/deactivations), only the first observation corresponding to a birth or the last observation corresponding to a death will be considered.[10] The second is that births and deaths may have their origin in acquisitions, mergers, spin-offs or simply in the fact that firms may become new legal entities and change their tax number. This constitutes an obvious, but unavoidable limitation. Although it is difficult to detect mergers or spin-offs among very small firms, it is likely that births of large firms are due to those type of corporate actions. Taking this fact into account, we exclude the births of firms with 250 or more employees. This

---

[10] Between 1995 and 2013, there are 1,907,908 observations corresponding to a firm birth; among these, 96,271 are repeated observations (i.e. 5,0%). Similarly, there is a total of 1,244,305 observations corresponding to a firm death; among these, 80,073 are repeated observations (i.e. 6,4%).

correspond to a total of 669 observations in the entire sample period (less than 0,04% of the total number of firm births).

In addition to this microdataset (covering entry and exit flows), the Central Business Register also provides data on the yearly distribution of aggregate employment and the total number of active firms by employment size bins.

SABI-CBI The second dataset is the so called SABI-CBI dataset, constructed by Almunia, López-Rodríguez and Moral-Benito (2016). This is a firm-level administrative dataset that combines data from two complementary sources: CBI (*Central de Balances Integrada*) - constructed by the Bank of Spain and available for in-house researches - and SABI (*Sistema de Análisis de Balances Ibéricos*) - constructed and commercialized by Bureau van Dijk. These two datasets have their origin in the Spanish Commercial Registry (*Registro Mercantil*), which contains the balance sheets of the universe of Spanish companies. Even though they target the same population of firms, the SABI and CBI datasets do not totally coincide; by merging the two, it is therefore possible to cover a wider universe of firms and a more representative micro-dataset of the Spanish economy (Almunia, López-Rodríguez and Moral-Benito (2016)). This dataset includes all sectors of the market economy excluding utilities, financial companies and self-employed persons.

For each firm, we observe its tax number, number of employees, revenues (gross output), total wage bill, materials, value added, book value of the capital stock (both tangible and intangible), total assets, short and long term debt, industry classification (at the 4-digit level, according to NACE Rev. 2) and year of birth. We use sector-specific deflators for total revenues, value added and the capital stock (constructed at the 2-digit NACE);[11] all remaining variables are deflated with the CPI.

Note that firms in SABI-CBI are identified by their tax number, so they can be matched to the DIRCE microdatabase. Given that DIRCE covers the universe of entry and exit for Spain, we can exactly know whether a firm in SABI-CBI corresponds to a birth or a death. However, not all births and deaths reported in

---

[11] Mas, Pérez, and Uriel (2013).

DIRCE will appear in SABI-CBI due to imperfect sampling.

Two Merged Databases			
Database	DIRCE	SABI-CBI	
Source	Spanish Statistical Office	Bank of Spain and *Bureau van Dijk*	
	Entry/Exit	Total Assets	Capital Stock
	Employment	Revenues	Value Added
	Industry	Materials	Total Wage Bill
		Employment	Debt
		Industry	Year of Birth

Table 1

As we show in appendix our dataset can replicate approximately 70% of the levels of gross output and employment reported in national accounts after 2000. It also closely replicates the aggregate size distribution of Spanish firms.

3.2.2 Firm Entry and Exit

In this section, we describe the dynamics of firm entry and exit in Spain over the 1996-2013 period. We document a significant decline in the Spanish startup rate, a phenomenon that appears to be prevalent across different firm size classes and industries. We also show a substantial reduction in the contribution of startups to aggregate job creation.

Following the standard practice in the literature (see Haltiwanger (2014, 2015)), we define the time t entry (exit) rate as the ratio of the total number of firm births (deaths) in a year t to the average number of active firms in years $t-1$ and t:[12]

$$\text{entry\_rate}_t = \frac{\mathrm{B}_t}{\frac{\mathrm{F}_t + F_{t-1}}{2}} \quad , \qquad \text{exit\_rate}_t = \frac{\mathrm{D}_t}{\frac{\mathrm{F}_t + F_{t-1}}{2}} \tag{3.1}$$

where B_t and D_t refer to the total number of firms births and deaths in year t and F_t represents the total number of active firms in the same year. Figure 3.4 shows the evolution of the aggregate entry and exit rates for the set of employer firms (i.e.

---

[12] This growth rate has two important advantages: it is symmetric (like log changes) and can accommodate zeros in the denominator (which can happen at fine levels of disaggregation).

firms with at least one employee). Some patterns are evident. First, the entry or startup rate is characterized by a pronounced downward trend from 1996 to 2007, declining from 12.3% in 1996 to 5.9% in 2007 (i.e. by 6.4 percentage points). This magnitude is considerable if we take into account that the U.S. startup rate declined by just 1 percentage point over the same period from 11.1% to 10.1% (see Table 2). Furthermore, in 1996 Spain was still starting a period of robust economic growth, which was the longest in its recent history.[13]

Second, the evolution of the aggregate exit rate exhibits a small downward trend between 1996 and 2007: it declines from 4.9% to 3.9% (i.e. by 1 percentage point). As a comparison, the US exit rate went from 8.4% to 8.3% over the same period (i.e. a 0.1 percentage point decline). In appendix 3.7.1 we also show the entry and exit rates over the crisis period 2008-2013.

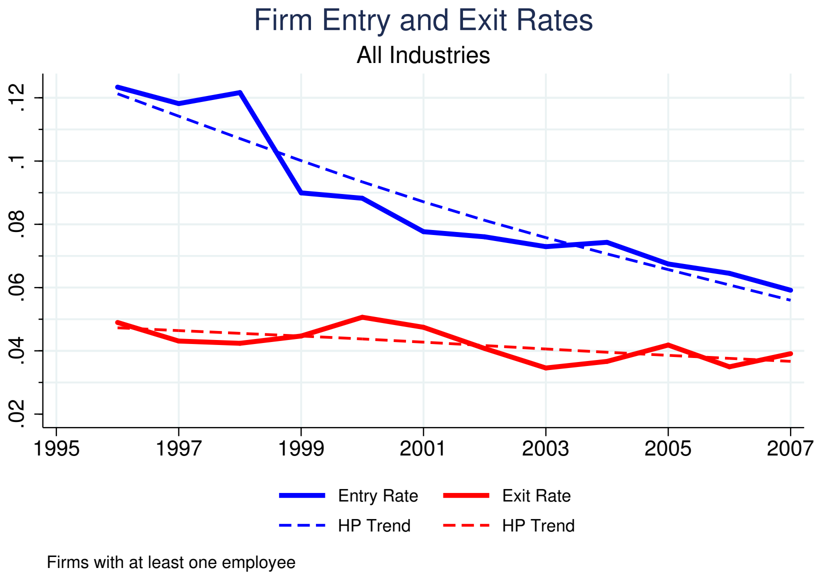


Figure 3.4: Entry and Exit Rates

---

[13] Between 1994 and 2007, Spanish GDP grew at an average rate of 3.5% per year (compared to a EU average of 2.2% over the same period).

	US			Spain		
	1996	2007	Δ (2007-1996)	1996	2007	Δ (2007-1996)
Entry rate	0.112	0.101	-0.011	0.123	0.059	-0.064
Exit rate	0.084	0.083	-0.001	0.049	0.039	-0.010
Job Entry Rate	0.03	0.025	-0.005	0.043	0.023	-0.020
Job Death Rate	0.024	0.023	-0.001	0.017	0.012	-0.005

Table 2

We also calculate entry and exit rates within specific employment size categories. We choose four size bins (1-5 employees, 6-9 employees, 10-19 employees and 20+ employees) for which the Central Business Registry provides data on the aggregate number of active firms. The results are displayed in Figure 3.5 below. As one can see, the decline in the entry rate can also be observed across different firm sizes over the 1996-2007 period. The decline in the exit rate is observed only within the 1-5 employees group.

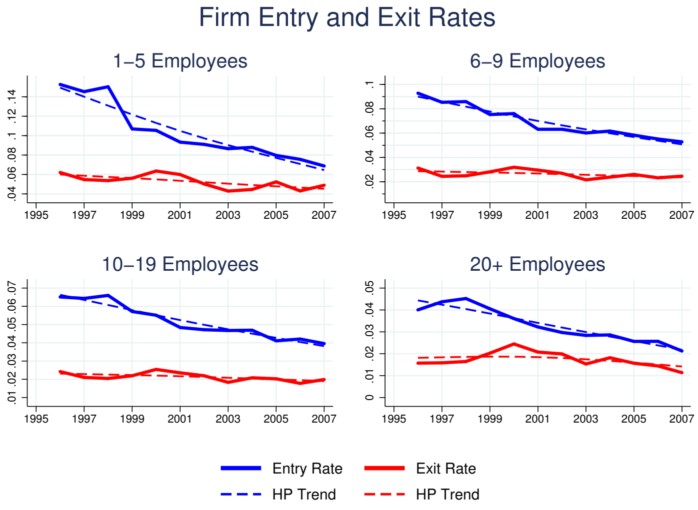


Figure 3.5: Entry and Exit Rates Across Different Firm Size Classes

Before proceeding to a more detailed analysis of the results, we provide some simple robustness checks. Given that Spain underwent a significant housing boom between 1995 and 2007, one may wonder whether the 'Construction' and 'Real Estate' sectors may have affected the previous numbers. Figure 3.22 in appendix

3.7.3 shows that very similar numbers are obtained when these sectors are excluded. Finally, we also ask whether the previous picture changes when firms with zero employees are also included. These firms were excluded from the analysis for two main reasons. First, because they mostly represent firms with no production, which are created for mere tax purposes. Second, these firms are also excluded in related studies on the dynamic of the US startup rate. As Figure 3.21 in appendix 3.7.2 shows, a downward trend in the startup rate can also be detected when firm with no employees are also included. Such decline is less pronounced but is still substantial: the entry rate declines from 13.6% in 1996 to 10.1% in 2007 (i.e. by 3.5 percentage points).

Finally, one may ask whether the drop in firm entry and exit rates can be attributed to changes in the denominator (i.e. a fall in the number of firm births and deaths) or rather to changes in the numerator (i.e. an increase in the total number of firms). Note that between 1996 and 2007 the entry rate is persistently above the exit rate, meaning that the total number of active firms steadily increases over this period. Figure 3.24 in appendix 3.7.4 shows that the total number of births declines from 1995 and 2007, though there is no clear downward trend (dark blue line). Indeed, there seems to be is a small but positive upward between 1999 and 2007 with the total number of births marginally increasing over this period. However, such apparent trend disappears when the 'Construction' and 'Real Estate' industries are excluded (light blue line). When looking at the evolution of the total number of deaths, there seems to be a small upward trend between 1995 and 2007 (dark red line). Overall, the total numbers of firm births and deaths seem to be stable in the pre-crisis period (especially between 2000 and 2007). The drop in firm entry and exit rates should therefore be attributed to the increase in the total number of firms during this period. This observation is true also for the US, where the total number of firm births and deaths increased between 1980 and 2007 in spite of the decline in the entry and exit rates (Figure 3.25).

Industry Disaggregation

Is the aggregate decline in entry and exit rates driven by a reduction in dynamism at the industry level or by a reallocation of economic activity towards less dynamic industries? To answer this question, we decompose the change in the aggregate entry (or exit) rate as

$$\triangle\gamma_t = \underbrace{\sum_i s_{it-1}\triangle\gamma_{it}}_{\triangle\text{within}} + \underbrace{\sum_i \gamma_{it-1}\triangle s_{it}}_{\triangle\text{between}} + \underbrace{\sum_i \triangle s_{it}\triangle\gamma_{it}}_{\triangle\text{reallocation}} \tag{3.2}$$

where γ_{it} refers to the entry (or exit) rate of industry i in year t and s_{it} the share of industry i in the aggregate number of firms. The first term represents a weighted average of the within-industry change in entry rates. The second term reflects whether industries with initially low entry rates have gained share in the aggregate number of firms. The third and last term captures whether industries gaining share experienced larger declines in the entry rates. Note that to apply the above decomposition, we need to have data on the total number of firms by 4-digit industry. Since we do not have such data from national accounts, we use the number of active firms in our dataset to compute entry and exit rates. This procedure may however be problematic since coverage increases substantially in the initial years of our data. Indeed, Figure 3.27 in appendix 3.7.6 compares the aggregate entry and exit rates computed in our dataset to the ones obtained from the Central Business Registry and shown in Figure 3.4. As we can see, there is a much larger drop in the entry and exit rate computed in our dataset, which is explained by the fact that the coverage increases in the initial years. However, between 2003 and 2007 the entry rate computed in our dataset moves almost in parallel with the one computed with data from national accounts. We then apply the decomposition in equation (3.2) for the period 2003-2007. The results are shown in Table 3 below. The decline in both the aggregate entry and exit rates seem to be exclusively driven by a reduction in the within-industry growth rates; the between-industry and reallocation terms are negligible.

Entry and Exit Rates: 2003-2007

	Δ Total	Δ Within	Δ Between	Δ Reallocation
Entry Rate	-0.017	-0.017	0.001	-0.002
Exit Rate	0.002	0.002	-0.001	0.001

Table 3

We also provide a histogram of the change on the industry-level entry and exit rates over the 2003-2007 period (Figure 3.6 below). This gives a more complete description of evolution of entry and exit rates across industries. As we can see on the left panel, the decline in the startup rate seems to be a phenomenon prevalent across industries. Indeed, 418 out of 581 industries (i.e. 71.9%) experience a decline in the entry rate between 2003 and 2007. When we analyze changes in the exit rate, the results are less pronounced: 265 out of 581 industries (i.e. 45.6%) experienced a decline in the exit rate.

4–digit NACE Rev 2
581 industries included (industries with less than 20 firms were not included)

Figure 3.6: Changes in Entry and Exit Rates Across 4-Digits Industries (03-07)

Job Entry and Job Exit Rates

The rates of firm entry and exit focus exclusively on the number of firms created or destroyed in a given year, thus providing no information on their shares in economic activity. Indeed, the decline in the startup rate might not be a reason for concern if startups were accounting for an increasing share of aggregate employment. In this subsection, we examine the evolution of job creation and destruction rates due to firm entry and exit. We define the job entry and exit rates as

$$\text{job\_entry\_rate}_t = \frac{\mathrm{E}_t^B}{\frac{\mathrm{E}_t + E_{t-1}}{2}} \quad , \ \text{job\_exit\_rate}_t = \frac{\mathrm{E}_t^D}{\frac{\mathrm{E}_t + E_{t-1}}{2}} \qquad (3.3)$$

where E_t^B and E_t^D refer to the total employment of firm births and deaths in year t and E_t represents aggregate employment in the same year. Figure 3.7 shows the evolution of the aggregate job entry and exit rates. As we can see, there is a persistent decline in the employment share of startups in the pre-crisis period: it falls from 4.3% in 1996 to 2.3% in 2007 (i.e. a 2 percentage point decline). The job exit rates exhibits a smaller drop: it falls from 1.7% in 1996 to 1.2% in 2007 (i.e. a 0.2 percentage point decline). Note that these magnitudes are substantial when compared to their US counterparts over the same period: the employment shares account for by startups declined from 3.0% to 2.5% (by 0.5 percentage points), whereas the employment share decreased from 2.5% to 2.3% (by 0.2 percentage points). Finally, there seems to be a downward trend in terms of total startup jobs between 1995 and 2007, especially when the 'Construction' and 'Real Estate' industries are excluded (Figure 3.26 in appendix 3.7.5). Overall, the results point to a significant decline in the startup rate in Spain over the 1995-2007 period. But have the characteristics of entrants also changed over time? For example, do startups exhibit higher survival rates or larger productivity levels? These and other questions are addressed in the next section.

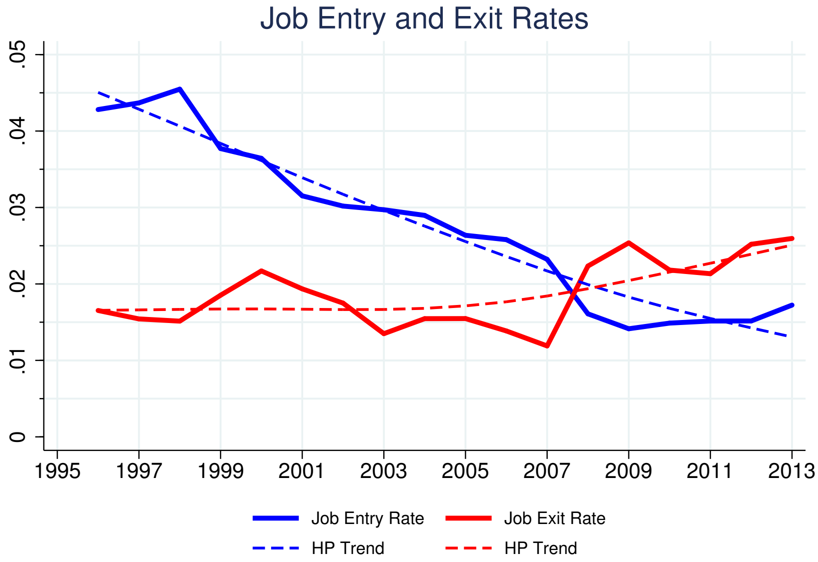


Figure 3.7: Job Entry and Exit Rates

3.2.3 Entrants' Characteristics

The evidence shown above indicates a significant decline in both (i) the startup rate and (ii) in the employment share of startups in Spain. However, the fact that entrants account for progressively lower employment shares might not be an indication of lower dynamism if young firms have become increasingly more resilient, with higher growth or survival rates. In this section, we aim at examining the evolution of some entrants' characteristics. We will characterize how the size distribution of startups, their survival probabilities and growth rates have evolved over time. Additionally, we will also provide evidence on the evolution of their productivity relative to incumbents.

Entrants' Firm Size Distribution

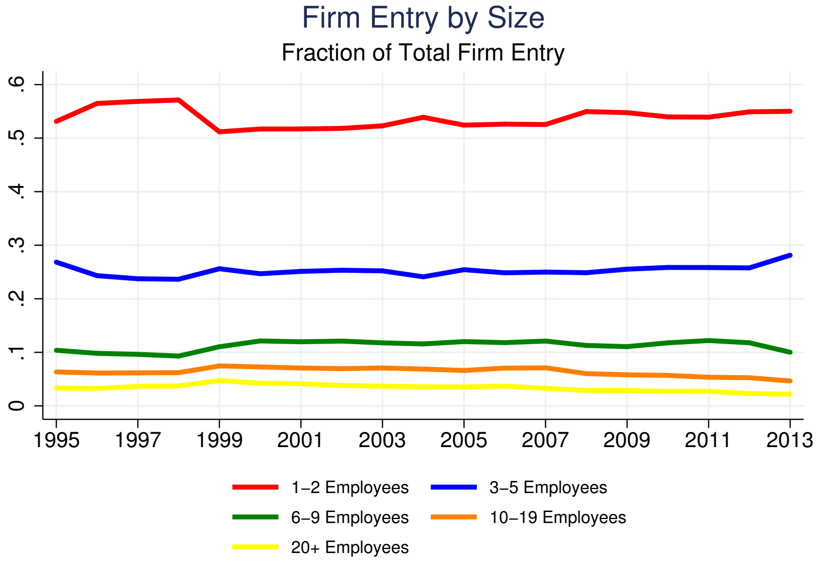


Figure 3.8: Firm Size Distribution of Startups

How does the size distribution of Spanish startups look like? Have there been significant changes over time? Figure 3.8 shows the firm size distribution of Spanish startups over the period 1995-2013. Recall that we can observe the employment levels for the universe of Spanish startups, so this distribution reflects the entire population of Spanish startups. As we can see, startups tend to be very small firms: firms with 1 or 2 employees typically account for 52-55% of the total number of startups. This share has remained fairly stable over time. Indeed, there seems to be no significant trend in terms of the size distribution of startups (all the five shares considered are quite stable over time).

Entrants' Survival and Growth Rates

In spite of their stable size distribution, startups may have changed along other dimensions. For example, they may have displayed increasingly higher survival or growth rates. In such case, the declining employment contribution of startups would be compensated by lower job destruction or higher job creation after the year of birth. Has the survival rate of new Spanish firms increased over time? And conditional on surviving, do startups grow faster? To answer these questions we compute survival and employment growth rates for startups. We look at the initial 5 years of each firm and discriminate the results by (initial) employment size. Moreover, we focus on firms created over the period 1995-2002 (so that their initial five years do not coincide with the recession years 2008-2013). The results are shown in Figure 3.9. The left panel shows the 5-year survival rate, i.e. the fraction of firms entering in a given year that were still active after 5 years (by initial employment size). The right panel shows the average employment growth rate $\frac{\text{emp}_{j,t+5}}{\text{emp}_{j,t}}$ for the universe of surviving firms. Two facts stand out. In first place, there is no significant trend in the 5-year survival probability of startups: they all remain stable at around 70%-75%. An exception applies perhaps to startups with initial employment size between 20 and 100 employees, whose 5-year survival rate increases from 72.0% to 75.4%. Note however that these firms represent less than 4% of all entry registered in the period. Second, conditional on surviving, startups achieve lower 5-year employment growth rates. This fact is observed for all groups, but is particularly evident for firms starting with up to 2 employees: small firms entering in 1995 would increase employment by a factor of 3.84 within 5 years, whereas those entering in 2002 would increase by a factor of 3.27.

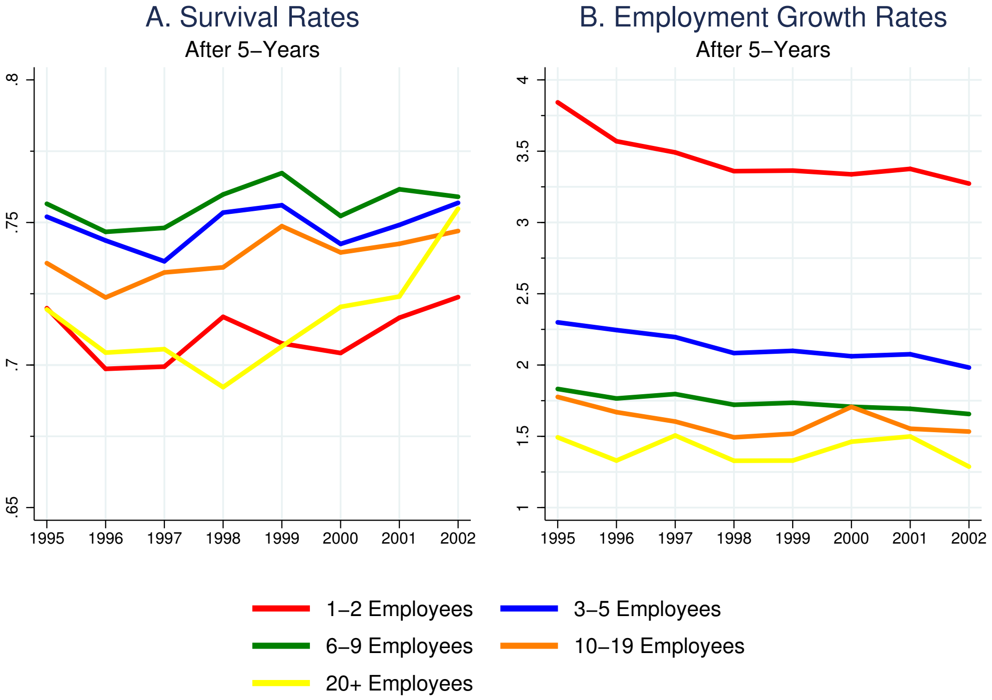


Figure 3.9: Startups' Surviving and Growth Rates

Taken together these two facts imply that firms entering in the later part of the sample were not more likely to survive, but would achieve lower growth rates conditional on surviving. These facts give us a more complete picture on the evolution of business dynamism in Spain. On the one hand, the entry rate has declined, while the size distribution of startups did not change significantly. On the other hand, young firms do not seem to exhibit higher surviving rates. Furthermore, they exhibit declining growth rates conditional on surviving. These facts suggest that the share of young firms (and not just startups) either in the aggregate number of firms or in aggregate employment may have declined. In appendix 3.7.7 we confirm this conjecture. We construct the firm and employment shares of young firms (with five or less years) and show that these have displayed a pronounced downward trend. Once again, the magnitude of the declines is larger than that observed for the US over the same period.

Productivity

As we have seen, the decline in the entry rate has been accompanied by a decrease of entrants' growth rates. One possible explanation for this fact is that incumbents may have become relatively more productive, making it more difficult for new firms to survive. In this subsection, we assess this hypothesis by characterizing the evolution of entrants' productivity relative to incumbents. Note that in spite of observing the employment levels for the universe of Spanish startups (as provided by DIRCE), we only have data on other balance sheet variables for a subset of these firms (the ones that are covered in SABI-CBI, which is not a census database).[14]

We define the revenue productivity level of firm j (belonging to industry i) in year t as

$$\text{rtfp}_{ijt} := \log\left(\text{va}_{ijt}\right) - \alpha_i \log\left(\text{k}_{ijt}\right) - (1-\alpha_i)\log\left(\text{emp}_{ijt}\right)$$

where va_{ijt} , k_{ijt} and emp_{ijt} represent value added, capital stock and employment. α_i is an industry-specific capital share. To assess whether entrants' productivity has changed with respect to that of incumbents of the same industry, we consider the following regression

$$\text{rtfp}_{ijt} = \alpha \cdot \underbrace{\text{entrant}_{ijt}}_{\in\{0,1\}} + \beta \cdot [(t-1998)\times \text{entrant}_{ijt}] + \theta_{it} + u_{ijt} \qquad t = 1998, ..., 2013 \tag{3.4}$$

where entrant_{ijt} is an indicator variable that takes value one if the firm is an entrant (and zero otherwise) and θ_{it} is an industry-time fixed effect. We include in the set of entrants all firms with which are between 1 and 3 years.[15]

---

[14] The fraction of startups with non-missing and non-zero values for revenues, value added and capital stock is 34% over the 1995-2013 period. This number increases from 13.4% in 1995 to 43.4% in 2013.

[15] We excluded firms that are in the first year of life, as these may include extremely young firms (e.g. less than 2 months) that haven't still started production. The inclusion of these firms would not affect our results. We have also considered alternative criteria (such as firms between 1 and 5 years), but they all delivered similar results.

Entrants-Incumbents RTFP Gap: 1998-2007					
	(1)	(2)	(3)	(4)	(5)
	All Industries	Manufacturing	Construction	Trade	Services
VARIABLES	rtfp$_{jit}$	rtfp$_{jit}$	rtfp$_{jit}$	rtfp$_{jit}$	rtfp$_{jit}$
α	-0.123***	-0.190***	-0.0988***	-0.119***	-0.0941***
	(0.00725)	(0.0129)	(0.0103)	(0.0107)	(0.0163)
β	0.00830***	0.0139***	0.00147	0.0135***	0.00462*
	(0.00173)	(0.00144)	(0.00278)	(0.00157)	(0.00251)
Observations	3,120,049	583,112	615,481	853,327	1,068,129
R-squared	0.691	0.578	0.048	0.596	0.781
Industry × Year FE	YES	YES	YES	YES	YES
Number of Industries	505	232	23	91	159

Industry-clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4

Data is from DIRCE and SABI-CBI 1995-2013. Firms with with value added and capital stock of 5,000 euros or less were excluded.

We are interested in the sign of $\hat{\beta}$, which reflects how the entrants-incumbents productivity gap has changed over time. We run (3.4) on the full sample (which includes 505 industries at the 4-digit level) and report the coefficient estimates in the first column of Table 4. Note that the estimate of α is negative (and significant), meaning that entrants are on average less productive (relative to incumbents of the same industry). Note that the magnitudes reported in Table 4 are substantial. Indeed, we obtain $\hat{\alpha} = -0.123$ which means that the entrants-incumbents productivity gap was on average -0.123 log points in 1998. However, by 2007 such gap is equal to -0.048 log points, i.e. it narrows by more than half between 1998 and 2007. In columns 2 to 5 we run the regression by sector of activity. This trend seems to be observable across all sectors, with the exception of Construction where the estimate of $\hat{\beta}$ is not statistically significant (though it is still positive). The results seem particularly strong within Manufacturing and Trade. In appendix 3.8, we report results for specific firm size classes. These trends are observable within most size categories considered.

We also estimate a flexible version of equation (3.4), where we allow the entrants-incumbents RFTP gap to evolve in a non-linear way

$$\text{rtfp}_{ijt} = \alpha\cdot\underbrace{\text{entrant}_{ijt}}_{\in\{0,1\}} + \sum_{t=1999}^{2007}(\beta_t \times \text{entrant}_{ijt} \times \underbrace{\text{year}_t}_{\in\{0,1\}}) + \theta_{it} + u_{ijt} \qquad t = 1998, ..., 2013$$

The estimates $\left\{\hat{\beta}_t\right\}_{1999}^{2007}$ are displayed in Figure (3.10).

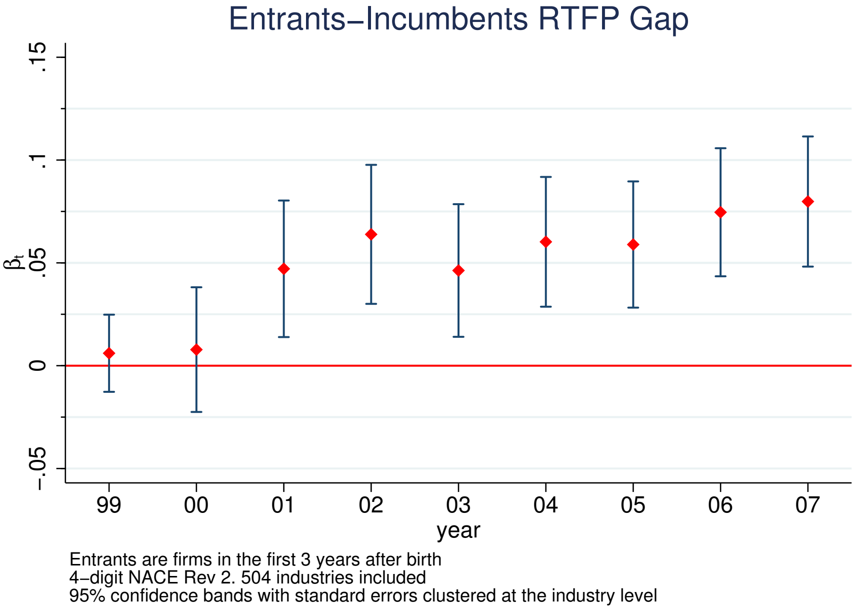


Figure 3.10: Entrants-Incumbents RTFP Gap

3.2.4 Summary of the Main Empirical Findings

In this section we have documented a decline in the Spanish firm entry and exit rates. Between 1996 and 2007, the Spanish startup rate exhibited a pronounced decline from 12.3% to 5.9% (i.e. by 6.4 percentage points), whereas the exit rate decreased from 4.9% to 3.9% (i.e. by 1 percentage point). As we have explained, these magnitudes are large if we take into account the US experience over the same period.

The decline in the entry rate has not been accompanied by neither an increase in the surviving probability of startups, nor in their post-entry growth rates. Indeed, we showed that the 5-year surviving probability of startups has remained highly stable, while their 5-year employment growth rate (conditional on survival) has actually declined. However, we have shown that young firms have become relatively more productive when compared to incumbents of the same industry.

We next present a model featuring firm dynamics and financial frictions to explain how an interest rate decline can explain why (i) the rates of firm entry and exit may have declined and (ii) young firms have become relatively more productive. We focus on a decline in interest rates because this is a major shock affecting the Spanish economy over the period we consider, whose implications have actually been studied in other contexts.[16]

3.3 The Model

Our model builds upon the framework of Melitz (2003). Time is discrete. We focus on a small open economy that can borrow and lend at the world riskless interest rate R.

3.3.1 Demand

There is a final tradable good Y that is a CES aggregate of a continuum of different varieties $i \in [0, M]$

$$Y = \left(\int_0^M y_i^\rho \, \mathrm{di} \right)^{\frac{1}{\rho}}$$

where $\sigma := \frac{1}{1-\rho}$ is the elasticity of substitution between different varieties. We take this final good as the *numeraire* and hence normalize its price to $P = 1$. We assume that due to technological constraints intermediate varieties are non-tradable. The price of each domestic variety will therefore be determined domestically. The (inverse) demand for each variety i is given by

$$p_i = \left(\frac{Y}{y_i} \right)^{1-\rho} \tag{3.5}$$

---

[16] See for instance Gopinath et al. (2017).

3.3.2 Production

Each variety i is produced by one firm that combines capital k_i and labor l_i through a Cobb-Douglas technology

$$y_i = \varphi_i k_i^{\alpha} l_i^{1-\alpha} \tag{3.6}$$

where φ_i is the idiosyncratic productivity of firm i. Capital depreciates at rate $\delta \in (0,1)$. Production also entails a fixed production cost $c_f > 0$ per period. We assume this fixed cost is invested one period before production.

Financial Frictions One important aspect of our model is that firms may be subject to a credit constraint. To motivate our credit market friction, we will assume that the economy contains a pool of agents (the *farmers*), who use capital to produce a good that can only be used for their own consumption. We shall assume that such consumption good is not pledgeable, so that farmers can only pledge their undepreciated capital stock when borrowing.

We will assume that when an entrepreneur creates a firm in the intermediate goods sector, he cannot be immediately distinguished from farmers. Therefore, he can only pledge his undepreciated capital stock, therefore facing the following credit constraint:

$$R\left(k + c_f - e\right) \leq \left(1 - \delta\right) k \tag{3.7}$$

where e is the internal wealth or equity owned by each firm. We will assume that young firms have the same level of equity. This assumption is made for the sake of simplicity - this way we will not need to keep track of firms' wealth accumulation. Although restrictive, this assumption will not be critical for our results, as we shall explain later. Moreover, we assume that $e > c_f$ so that constrained entrepreneurs have always sufficient wealth to cover the fixed production cost c_f.

To be distinguished from farmers, firms need to be audited by creditors. We assume that, at each moment in time, creditors can costlessly observe the output of a fraction $\mu \in (0,1)$ of all constrained firms. Therefore, constrained firms face a constant probability $\mu \in (0,1)$ of becoming unconstrained.

We will impose parameter conditions to guarantee that, before being audited by creditors, new firms are always constrained in equilibrium (so that (3.7) binds across all productivity types). This will happen if internal equity e is not too high.

Factor Demand We start by solving the static profit maximization profit of unconstrained firms. Note that given our assumption of a Cobb-Douglas production function, unconstrained firms will be able to produce at a constant marginal cost. The marginal cost of an unconstrained firm with productivity φ is equal to

$$q\left(\varphi\right) := \frac{1}{\varphi}\left(\frac{W}{1-\alpha}\right)^{1-\alpha}\left[\frac{R-\left(1-\delta\right)}{\alpha}\right]^{\alpha} \tag{3.8}$$

where W is the wage rate and R is the gross interest rate. Each firm will thus produce the quantity q_i that maximizes total profits, i.e.

$$\max_{y_i}\ \left(p_i - q_i\right) y_i - Rc_f \quad \text{s.t.} \quad p_i = \left(\frac{Y}{y_i}\right)^{1-\rho}$$

The solution to this problem yields a price that consists of a constant markup ρ^{-1} over the marginal cost. An unconstrained firm with productivity φ will therefore charge a price

$$p^U\left(\varphi\right) = \frac{1}{\rho}\cdot q\left(\varphi\right) \tag{3.9}$$

The monopoly profits made by an unconstrained firm with productivity φ will be equal to

$$\pi^U\left(\varphi\right) = \left(1-\rho\right)\left[\frac{\rho}{q\left(\varphi\right)}\right]^{\frac{\rho}{1-\rho}} Y - Rc_f \tag{3.10}$$

We now turn to the problem of constrained firms. The maximum capital stock that a constrained firm can use is equal to

$$\bar{k} := \underbrace{\frac{R}{R-\left(1-\delta\right)}}_{\text{leverage}}\left(e - c_f\right)$$

Constrained firms will solve

$$\max_{l_i}\ p_i y_i - W l_i - \left[R-\left(1-\delta\right)\right] k_i - Rc_f \quad \text{s.t.} \quad \begin{aligned} p_i &= \left(\tfrac{Y}{y_i}\right)^{1-\rho} \\ k_i &= \bar{k} \end{aligned}$$

Their labor demand is given by

$$l^C\left(\varphi\right) = \left[\frac{\rho\left(1-\alpha\right)}{W} Y^{1-\rho}\left(\varphi\bar{k}^{\alpha}\right)^{\rho}\right]^{\frac{1}{1-\rho\left(1-\alpha\right)}}$$

So that they make revenues

$$r^{C}\left(\varphi\right)=Y^{\frac{1-\rho}{1-\rho(1-\alpha)}}\left[\frac{\rho\left(1-\alpha\right)}{W}\left(\varphi\bar{k}^{\alpha}\right)^{\frac{1}{1-\alpha}}\right]^{\frac{\rho(1-\alpha)}{1-\rho(1-\alpha)}}$$

and profits

$$\pi^{C}\left(\varphi\right)=\left[1-\rho\left(1-\alpha\right)\right]r^{C}\left(\varphi\right)-\left[R-\left(1-\delta\right)\right]\bar{k}-Rc_{f}$$

Productivity Process When a firm is born, it will make an initial productivity draw φ_i from a Pareto distribution with shape parameter ν

$$\Pr\left[\varphi_i\leq\varphi\right]=1-\varphi^{-\nu} \tag{3.11}$$

In the standard Melitz (2003) model, firms keep their idiosyncratic productivity fixed throughout their life. Furthermore, they can be hit by an exogenous death shock that arrives at constant probability. This implies that firms will face a constant exit probability every period (which corresponds to the probability of receiving the death shock). Having an exogenous exit rate would however be unsuitable for our purposes, given that we precisely want to explain the decline in firm entry and exit rates. We therefore modify the basic Melitz (2003) framework and introduce idiosyncratic productivity shocks. In particular, we assume that with probability $\lambda\in(0,1)$ each firm will be forced to make a new productivity draw. Such draw is made from the Pareto distribution given in (3.11). With probability $1-\lambda$, firms will maintain their productivity level across periods.

One way to interpret this setting is to think of varieties as products that can become obsolete. Firms produce a given variety with constant productivity. When a variety gets obsolete, firms make a new productivity draw and start producing a new variety.

Time is therefore as follows

- Production takes places
- Next period's productivity is realized
- Firms make a continuation/exit decision. In particular, firms need to decide whether to remain active (thus incurring in the fixed production cost c_f) or to exit

We next explain how such continuation/exit decision is made.

Endogenous Exit Decisions Firms will have to make a continuation/exit decision every period. After knowing next period's productivity, each firm will need to decide whether to stay on the market or exit. For the firm to remain active it needs to pay the fixed production cost c_f. The value of an active unconstrained firm with productivity φ therefore given by

$$V^U(\varphi) = \frac{1}{R}\Big\{\pi^U(\varphi) + (1-\lambda)\, V^U(\varphi) + \lambda \cdot V_0^U\Big\}$$

where V_0^U is the value of making a new productivity draw for an unconstrained firm. This equation says that the value of an active unconstrained firm has two components. The first consists of the monopoly profits $\pi^U(\varphi)$ that the firm makes in the subsequent period. The second is the continuation value. With probability $1-\lambda$ the firm will keep its productivity unchanged and hence will have the same value $V^U(\varphi)$. With probability λ, the firm will make a new productivity draw and will have a value V_0^U (which is independent of φ). Note however that an unconstrained firm will decide to exit whenever its idiosyncratic productivity is below a cutoff $\underline{\varphi}^U$ which is defined as

$$V^U\left(\underline{\varphi}^U\right) = 0 \Leftrightarrow \underline{\varphi}^U = \left[\frac{Rc_f - \lambda V_0^U}{(1-\rho)\, Y}\right]^{\frac{1-\rho}{\rho}} \frac{1}{\rho}\left(\frac{W}{1-\alpha}\right)^{1-\alpha}\left[\frac{R-(1-\delta)}{\alpha}\right]^{\alpha}$$

We can therefore write

$$V^U(\varphi) = \begin{cases} 0 & \text{if} \quad \varphi < \underline{\varphi}^U \\ \dfrac{\pi^U(\varphi) + \lambda V_0^U}{R-(1-\lambda)} & \text{if} \quad \varphi \geq \underline{\varphi}^U \end{cases} \tag{3.12}$$

Finally, note that the value of making a new productivity draw for an unconstrained firm is equal to

$$V_0^U := \int_{\underline{\varphi}^U}^{\infty} V^U(\varphi) \cdot f(\varphi)\ d\varphi$$

We now define the value of a constrained firm. Upon making a new productivity draw for the following period, each constrained firm may decide to immediately exit. This will happen whenever the idiosyncratic productivity level is below some cutoff $\underline{\varphi}^C$. If the firm does not exit, it will produce with productivity φ. The value of being an active constrained firm with idiosyncratic productivity φ in the following period is equal to

$$V^C(\varphi) = \frac{1}{R}\Big\{\pi^C(\varphi) + (1-\lambda)\left[(1-\mu)V^C(\varphi) + \mu V^U(\varphi)\right] + \lambda\left[(1-\mu)V_0^C + \mu V_0^U\right]\Big\}$$

This equation says that the value of an active constrained firm has two components. The first consists of the monopoly profits $\pi^C(\varphi)$ that the firm makes in the following period. The second is the continuation value. With probability $(1-\lambda)$ the firm will keep its productivity unchanged. It then remains constrained with probability $(1-\mu)$ or becomes unconstrained with probability μ. With probability λ the firm may however make a new productivity draw. Again, it can remain constrained with probability $(1-\mu)$ or become unconstrained with probability μ.

A constrained firm will not exit provided that its idiosyncratic productivity level is above a productivity threshold $\underline{\varphi}^C$ which is implicitly defined by

$$V^C\left(\underline{\varphi}^C\right) = 0$$

We may therefore write

$$V^C(\varphi) = \begin{cases} 0 & \text{if} \quad \varphi < \underline{\varphi}^C \\ \dfrac{\pi^C(\varphi) + (1-\lambda)\mu V^U(\varphi) + \lambda\left[(1-\mu)V_0^C + \mu V_0^U\right]}{R - (1-\lambda)(1-\mu)} & \text{if} \quad \varphi \geq \underline{\varphi}^C \end{cases}$$

Finally, note that the value of making a new productivity draw for a constrained firm is given by

$$V_0^C := \int_{\underline{\varphi}^C}^{\infty} V^C(\varphi) \cdot f(\varphi)\ d\varphi$$

Firm Entry There is a large an unbounded mass of prospective entrants. In order to enter firms need to make a sunk investment $c_e > 0$ in units of the final good. This includes the setup costs of building a new plant, as well as the opportunity cost of starting a business. After paying the entry cost, firms draw a productivity level from the Pareto distribution given in (3.11).

3.3.3 Stationary Equilibrium

We focus on a stationary equilibrium. We need to determine seven endogenous variables: aggregate output (Y), the wage rate (W), the exit cutoffs for constrained firms ($\underline{\varphi}^C$) and for unconstrained firms ($\underline{\varphi}^U$), the number of constrained firms (M^C) and of unconstrained firms (M^U) and the number of firms paying the entry cost every period (n). We next derive the seven equilibrium conditions that characterize a stationary equilibrium of our model.

In equilibrium, total output Y must equal aggregate revenues

$$Y = M^C \cdot \int_{\underline{\varphi}^C}^{\infty} r^C(\varphi) \cdot \frac{f(\varphi)}{1 - F\left(\underline{\varphi}^C\right)} \, d\varphi \; + \; M^U \cdot \int_{\underline{\varphi}^U}^{\infty} r^U(\varphi) \cdot \frac{f(\varphi)}{1 - F\left(\underline{\varphi}^U\right)} \, d\varphi$$

We assume that there is a constant labor supply L. Labor market clearing therefore requires that total labor supply equals total labor demand

$$L = M^C \cdot \int_{\underline{\varphi}^C}^{\infty} l^C(\varphi) \cdot \frac{f(\varphi)}{1 - F\left(\underline{\varphi}^C\right)} \, d\varphi \; + \; M^U \cdot \int_{\underline{\varphi}^U}^{\infty} l^U(\varphi) \cdot \frac{f(\varphi)}{1 - F\left(\underline{\varphi}^U\right)} \, d\varphi$$

Since there is a large and unbounded mass of prospective entrants, each firm paying the entry cost shall not make positive profits in expectation. Therefore

$$\underbrace{\int_{\underline{\varphi}^C}^{\infty} V^C(\varphi) \cdot f(\varphi) \; d\varphi}_{V_0^C} = c_e$$

In a stationary equilibrium, the number of constrained firms must be constant. This requires that the number of firms that exit the constrained state equals the number of firms that become constrained. The first consists of all constrained firms that are either audited by creditors - a fraction μ - or that are not audited but which make a new productivity draw below $\underline{\varphi}^C$ - a fraction $(1-\mu)\,\lambda F\left(\underline{\varphi}^C\right)$ of all constrained firms. The second corresponds to all new firms entering in the market - which corresponds to a fractions $\left[1 - F\left(\underline{\varphi}^C\right)\right]$ of all firms paying the entry cost (n).

$$\left[\mu + (1-\mu)\,\lambda F\left(\underline{\varphi}^C\right)\right] M^C = \underbrace{\left[1 - F\left(\underline{\varphi}^C\right)\right] \cdot n}_{\text{entry}}$$

Similarly, the number of active unconstrained firms must be constant. Therefore, the number of firms that stop being unconstrained must equal the number of firms that were constrained but become unconstrained (and remain active). The first is equal to the number of unconstrained firms making a new productivity draw below $\underline{\varphi}^U$ - a fraction $\lambda F\left(\underline{\varphi}^U\right)$ of all unconstrained firms. The later contains all firms that are audited but do not make a new productivity draw - a fraction $\mu(1-\lambda)$ of all constrained firms - or that are audited and make a new productivity draw above $\underline{\varphi}^U$ - a fraction $\mu\lambda F\left(\underline{\varphi}^U\right)$ of all unconstrained firms.

$$\lambda F\left(\underline{\varphi}^U\right) M^U = \left[\mu(1-\lambda) + \mu\lambda F\left(\underline{\varphi}^U\right)\right] M^C$$

Finally, we have two equations that determine the exit productivity cutoffs $\underline{\varphi}^C$ and $\underline{\varphi}^U$

$$V^C\left(\underline{\varphi}^C\right) = 0 \Leftrightarrow \pi^C\left(\underline{\varphi}^C\right) + (1-\lambda)\mu V^U\left(\underline{\varphi}^C\right) + \lambda\left[(1-\mu)V_0^C + \mu V_0^U\right] = 0$$

$$V^U\left(\underline{\varphi}^U\right) = 0 \Leftrightarrow \underline{\varphi}^U = \left[\frac{Rc_f - \lambda\cdot V_0^U}{(1-\rho)Y}\right]^{\frac{1-\rho}{\rho}} \frac{1}{\rho}\left(\frac{W}{1-\alpha}\right)^{1-\alpha}\left[\frac{R-(1-\delta)}{\alpha}\right]^{\alpha}$$

The model will not have an analytical solution and will need to be solved numerically. Before proceeding, and to provide some intuitions, we shall briefly describe the stationary equilibrium when there are no financial frictions.

No Financial Frictions

We start by removing financial frictions from our model. When there are no financial frictions, all firms are unconstrained. Appendix 3.11 characterizes the stationary equilibrium under this setting. The equilibrium exit productivity threshold $\underline{\varphi}$ can be written as

$$\underline{\varphi} = \left\{\frac{Rc_f - \lambda c_e}{\left[R-(1-\lambda)\right]c_e}\frac{\rho}{\nu(1-\rho)-\rho}\right\}^{\frac{1}{\nu}} \tag{3.13}$$

Therefore, the exit productivity threshold $\underline{\varphi}$ can be increasing or decreasing in the interest rate R depending upon parameters. The following lemma provides conditions under which such relationship is positive.

Lemma 1 *The exit productivity threshold $\underline{\varphi}$ is increasing in the interest rate R provided that*

$$c_f < \frac{\lambda}{1-\lambda} c_e$$

To understand this fact, note that the interest rate plays two effects in this model. One the one hand it affects the cost of remaining in operation (through the fixed production cost c_f). This effect induces a positive relationship between R and $\underline{\varphi}$: the lower the interest rate, the lower the minimum productivity threshold that is required for firms to break even. On the other hand, the interest rate affects the rate at which firms discount future profits. This effect induces a negative relationship between R and $\underline{\varphi}$: the lower the interest rate, the higher the present discounted value of future profits (*ceteris paribus*) and hence the higher is the threshold $\underline{\varphi}$ that is required to guarantee the free entry condition $V_0 = c_e$. To understand this effect, suppose that the profits that firms make at each productivity level φ are constant. If the productivity threshold $\underline{\varphi}$ is also fixed, a lower interest rate will necessarily imply a larger value of making a new productivity draw V_0 (because profits are discounted at a lower rate). This would however violated the free entry condition $V_0 = c_e$. Therefore, holding profits constant, the productivity threshold $\underline{\varphi}$ must increase for the free entry condition to be satisfied.

We will assume that the conditions of Lemma 1 are satisfied. Therefore, the exit productivity cutoff $\underline{\varphi}$ will decrease after a decline in the interest rate R. Note that as the exit productivity cutoff decreases, average productivity also falls. To see this note that, under our assumption of a Pareto distribution, average productivity is equal to

$$\tilde{\varphi} := \int_{\underline{\varphi}}^{\infty} \varphi dF(\varphi) = \frac{\nu}{\nu-1}\underline{\varphi}$$

The model can therefore explain how an interest rate decline can be associated with lower average TFP (a feature of the Spanish growth experience).

Firm Entry and Exit Rates The stationary entry and exit rates are equal to

$$\underbrace{\frac{\left[1-F\left(\underline{\varphi}\right)\right]n}{M}}_{\text{entry rate}} = \underbrace{\lambda F\left(\underline{\varphi}\right)}_{\text{exit rate}} \tag{3.14}$$

The equilibrium exit rate will correspond to the fraction of firms making a productivity draw below $\underline{\varphi}$. A lower productivity cutoff will be translated into a lower exit probability and hence a lower exit rate. Therefore, under the conditions of Lemma 1, a decline in the interest rate will be associated with a decrease in the equilibrium entry and exit rates. The mechanism is intuitive: by increasing the range of productivity values for which production is profitable, lower interest rates imply a decreased exit probability and hence a decreased exit rate.

As we can clearly see through equation (3.14), a lower exit rate is an immediate consequence of a lower exit productivity cutoff. The model therefore suggests that lower rates of dynamism and a decline in aggregate productivity (two features of the Spanish 1995-2007 experience) may be intimately related phenomena.

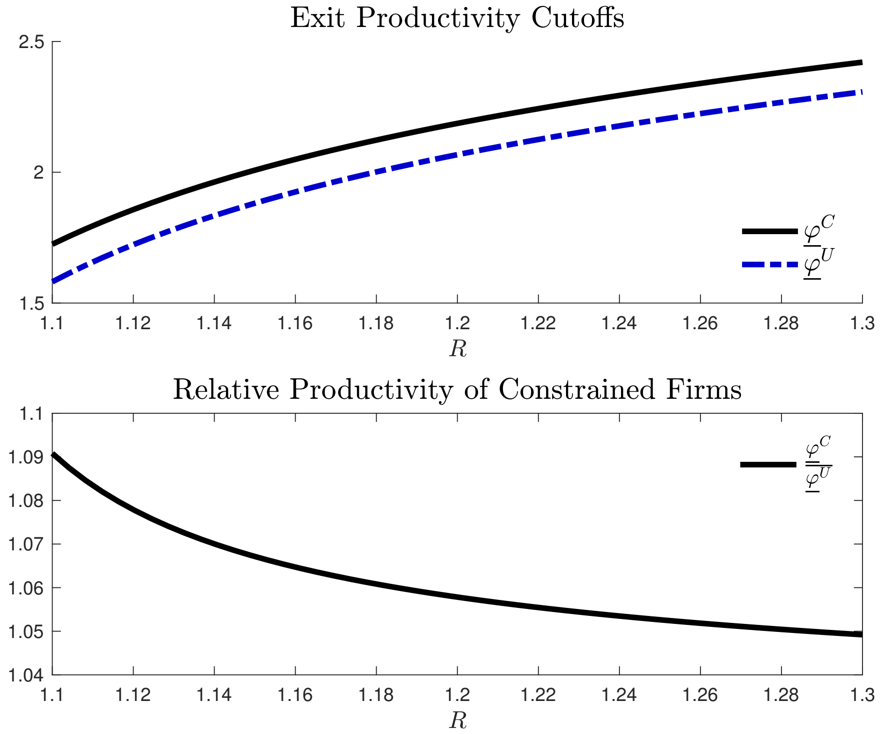
Note that, in spite of the decline in the firm entry and exit rates, the actual numbers of firms entering and exiting may actually increase. This happens because the total number of active firms may increase in response to a decline in the interest rate. To see this note that we can write the aggregate number of firms as

$$M = \frac{\nu (1-\rho) - \rho}{\nu (Rc_f - \lambda c_e)} Y$$

This simple version of the model cannot therefore explain how an interest rate decline can be associated with lower rates of firm entry and exit. Furthermore, it shows that the decrease in the entry and exit rates will be intimately related to the decrease in aggregate TFP. However, in this simple version of the model, all age cohorts are identical and hence there is no fundamental distinction between entrants and incumbents. The model cannot therefore explain one pattern that we observe in the data, namely that the productivity of entrants increased with respect to that of incumbents. We next show that the model with financial frictions can account for this fact.

Financial Frictions

Once financial frictions are present, we will be not able to provide an analytical characterization of the stationary equilibrium. We can however show that, under certain parameter conditions, there will be a negative relationship between the interest rate R and the exit productivity cutoffs $\underline{\varphi}^C$ and $\underline{\varphi}^U$. This is illustrated in the upper panel of Figure 3.11.

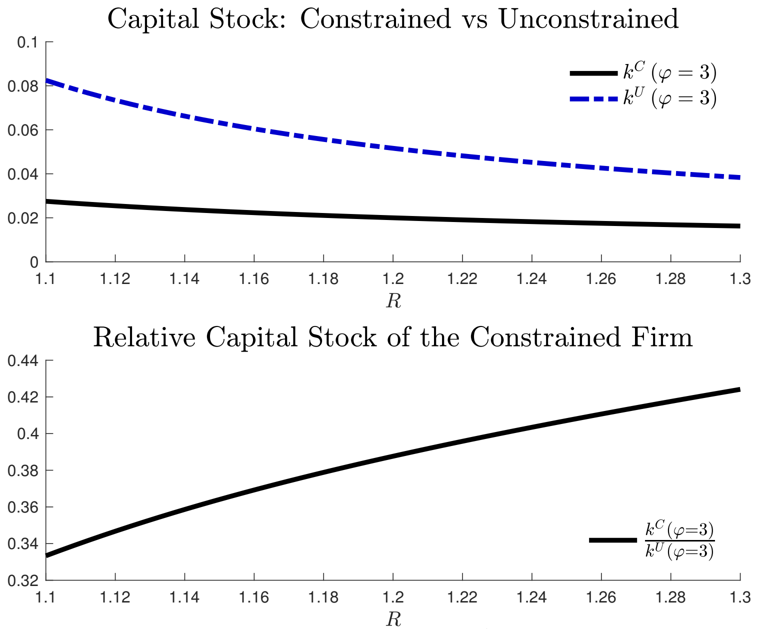

Exit Productivity Cutoffs

Relative Productivity of Constrained Firms

Parameters: $\rho = 0.6$, $\alpha = 0.3$, $\nu = 2$, $\lambda = 0.1$, $\mu = 0.1$, $\delta = 0.1$, $e = 0.025$ and $c_f = 0.02$

Figure 3.11: Productivity Cutoffs and the Interest Rate

The mechanism is similar to the model without financial frictions. A lower interest rate translates into a lower cost of operation and hence a lower productivity level required for firms to break even. What is perhaps interesting to note is that the productivity cutoff of unconstrained firms declines at a faster rate, so that $\underline{\varphi}^C$ increases with respect to $\underline{\varphi}^U$ (bottom panel of Figure 3.11). To understand this result, it is instructive to compare how the capital stock of a constrained firm evolves with respect to that of an unconstrained firm as the interest rate R decline. Figure 3.12 compares the capital stock of a constrained and an unconstrained firm with the same productivity level for different values of the interest rate R. As one can see, the capital stocks of the both firms increases as the interest rate R declines.



Parameters: $\rho = 0.6$, $\alpha = 0.3$, $\nu = 2$, $\lambda = 0.1$, $\mu = 0.1$, $\delta = 0.1$, $e = 0.025$ and $c_f = 0.02$

Figure 3.12: Capital Stock: Constrained versus Unconstrained Firms

The constrained firm has a higher capital stock because its constraint (3.7) is relaxed. The unconstrained firm increases its capital stock to take advantage of a cheaper input of production. Note however that the constrained firm increases its capital stock at a slower rate, so that its shrinks relative to the unconstrained firm (bottom panel). This result is crucial to understand why the exit productivity cutoffs of unconstrained firms $\underline{\varphi}^U$ declines faster than that of constrained firms. Since unconstrained firms increase their capital stock at a faster rate, they will be able to survive at relatively lower values of the productivity distribution. In other words, constrained firms cannot increase their capital stock as fast as unconstrained firms and need to be relatively more productive to survive.

Note that a relatively higher exit cutoff $\underline{\varphi}^C$ immediately implies that constrained firms become relatively more productive. To see this note that the average productivity of each group will be proportional to the respective exit cutoff, i.e.

$$\tilde{\varphi}^s := \int_{\underline{\varphi}^s}^{\infty} \varphi dF(\varphi) = \frac{\nu}{\nu - 1} \underline{\varphi}^s \quad , s = C, U$$

The model can therefore provide an explanation for why young firms have become relative more productive. As they could not increase their capital stock as fast as unconstrained firms, they had to be relatively more productive to survive. In appendix 3.9 we provide some evidence that corroborates the model's mechanism. In particular, we show that young firms display decreasing capital stocks and capital-labor ratios when compared to incumbents of the same industry.

Firm Entry and Exit Rates We finally look at the behavior of firm entry and exit rates. In a stationary equilibrium, the entry and exit rates are given by

$$\underbrace{\frac{\left[1-F\left(\underline{\varphi}^{C}\right)\right]n}{M}}_{\text{entry rate}}=\underbrace{\lambda F\left(\underline{\varphi}^{U}\right)\frac{\mu+(1-\mu)\lambda F\left(\underline{\varphi}^{C}\right)}{\mu+(1-\mu)\lambda F\left(\underline{\varphi}^{U}\right)}}_{\text{exit rate}}$$

Even though we cannot characterize analytically the relationship between the stationary firm entry and exit rates and the interest rate, we can show that under certain parameter conditions this relationship will be positive (Figure 3.13). An interest rate decline will therefore be associated with lower rates of firm entry and exit. The mechanism is somehow intuitive: lower interest rates will be associated with lower exit productivity cutoffs and these in turn imply a decreased probability of exit. Since in a stationary equilibrium the entry and exit rates coincide, the steady-state entry rate will also decrease in reaction to an interest rate decline.

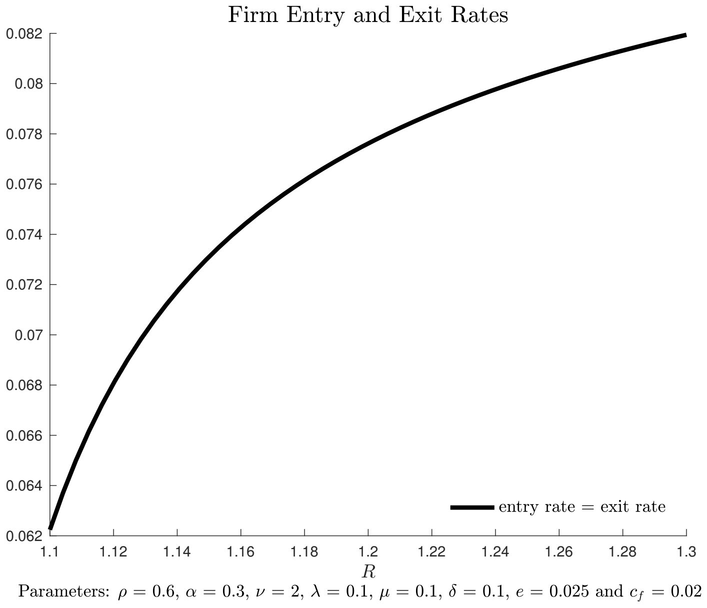


Figure 3.13: Firm Entry and Exit Rates

Discussion One could argue that the above results, and in particular the fact that young or constrained firms could not grow as fast as the unconstrained, crucially hinged on the fact that young firms had a fixed equity level e. If firms were allowed to accumulate wealth, constrained firms could perhaps benefit more from an interest rate decline as they could increase net worth at a faster rate. However, this may not always be the case. To understand this fact, note that a firm with initial equity e and that makes profits $\pi^C(\varphi)$ will have accumulated wealth

$$R \cdot e + \pi^C(\varphi)$$

Firms' accumulated wealth will therefore have two components: the return on past wealth $R \cdot e$ plus the profits that the firm makes. Therefore, an interest rate decline can have ambiguous effects on firms' accumulated net worth. On the one hand, it will be associated with higher profits $\pi^C(\varphi)$ (which increases accumulated wealth). On the other hand, it implies a lower return on past wealth $R \cdot e$ (which decreases accumulated wealth). Figure 3.14 shows how the accumulated wealth of constrained firms changes with the interest rate (all values refer to constrained firms with fixed productivity $\varphi = 3$ in a stationary equilibrium). As one can see, accumulated wealth can be non-monotonic in the interest rate.

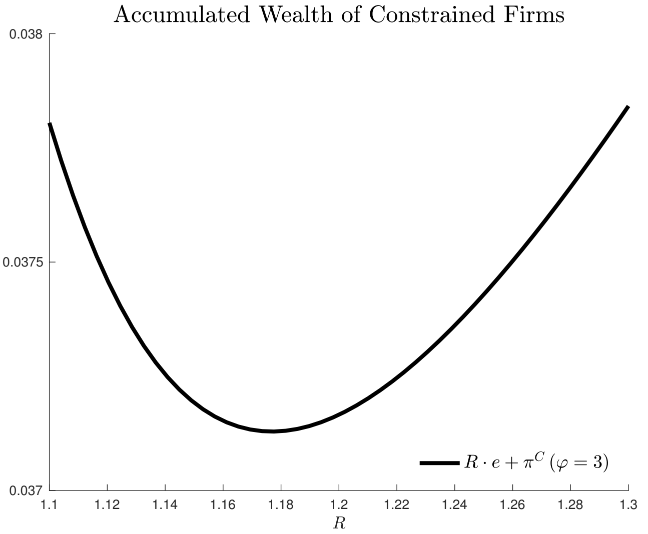


Figure 3.14: Accumulated Wealth of Constrained Firms

3.4 Conclusion

In this paper, we have studied the evolution of business dynamism in Spain between 1995 and 2007. Consistent with the evidence for other developed countries, we documented a large and persistent decline in the Spanish firm entry and exit rates over the period considered. We also showed that, when compared to incumbents of the same industry, entrants have become relatively more productive.

We have built a model featuring firm dynamics and financial frictions to show how an interest rate decline can generate these trends. Lower interest rates, by reducing operation costs, may be associated with a lower productivity cutoff required for firms to break even. This means that firms will be less likely to exit upon making a new productivity draw. In a stationary equilibrium, this fact translates into lower turnover and hence lower entry and exit rates.

Incumbent firms will however benefit more from the decline in interest rates. Being less subject to credit constraints, they can increase their their capital stock disproportionately more. As a result, their exit productivity cutoff declines at a faster rate. In other words, young firms (which are predominantly constrained) will have a relatively lower capital stock and will need to be on average more productivity to survive. At the heart of our model is the idea that a decline in interest rates will benefit disproportionately more larger or unconstrained firms. Such finding is in line with the results of Gopinath et al. (2017).

We conclude by briefly discussing the implications of our theory for the ongoing debate on the decline of dynamism. First, our theory suggests a rather benign view for the fall in business dynamism: lower rates of firm entry and exit may be the natural consequence of a decline in interest rates, which brings about a reduction in firms' operating costs. Can our model say something about the decline of business dynamism that has been documented for the US? Most explanations for the decline of dynamism in the US fall into two main categories: demographic trends and increased entry barriers. In this paper we have proposed a new mechanism, based on the decline in interest rates. An interesting aspect of our theory is that it can be applied to the US, which has also experienced a downward trend in real interest rates since the 1980s.

3.5 Appendix: Coverage and Representativeness of Our Dataset

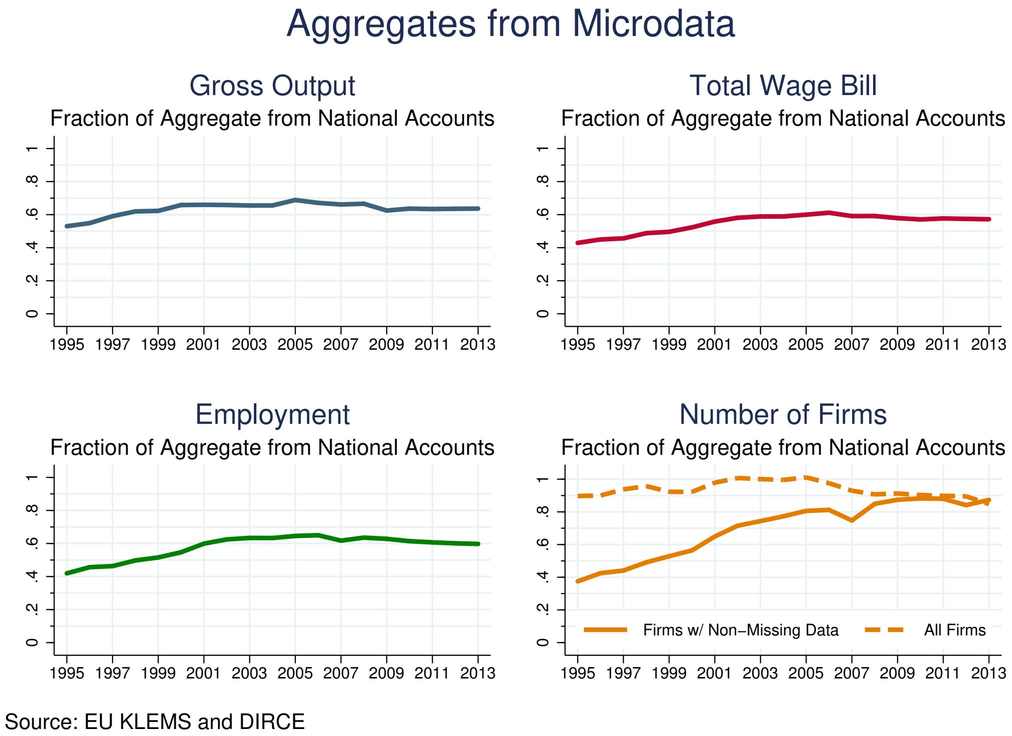
3.5.1 Comparison with National Accounts

We next characterize the coverage and representativeness of our dataset. Figure 3.15 compares the evolution of four different aggregates from our merged DIRCE-SABI-CBI dataset (gross output, total wage bill, total employment and total number of firms) against the corresponding macro-aggregates obtained from national accounts.[17] Since most of our analysis will later be carried out at the industry-level, we exclude observations with missing industry classification for the construction of the microaggregates. Moreover, we also exclude firm-year observations with missing or zero values for revenues and employment; these are the two variables that we will use to construct measures of industry concentration. As it is clear from Figure 3.15, the coverage in our data increases in the initial five years for all variables considered. For instance, the dataset accounts for 50% of aggregate gross output in 1995, but this fraction increases to roughly 70% in 2000. Note that the national accounts include the activity of self-employed individuals (who may represent 8%-10% of production) as well as an adjustment for the informal economy (which may represent 15%-20% of aggregate gross output and be higher in the recession period 2008-2013). Therefore, a coverage of 70% in terms of output is highly satisfactory. The coverage in terms of the total wage bill and employment also increases until 2001; it then remains stable, at around 60%. The right-bottom panel shows the number of firms in the dataset as a fraction of the aggregate number of firms with at least one employee reported in official statistics (full line). The coverage increases until 2009/2010, which may be explained by the fact that missing observations were more prevalent in the initial years of the sample. Note that after 2002, the dataset contains between 70% and 90% of all active Spanish firms with at least one employee. The dashed line shows the ratio of the total number of firms in DIRCE-SABI-CBI without excluding firms with missing or zero values (for employment, turnover or industry classification) to the

---

[17] Macro-aggregates for gross output, total wage bill and total employment were obtained from EU KLEMS; the total number of firms is from DIRCE.

aggregate number of firms reported in official statistics (including firms with zero employees). As one can see, our combined DIRCE-SABI-CBI datasets contains between 90% and 100% of all active firms reported by the official statistics.



Source: EU KLEMS and DIRCE

Figure 3.15: Micro-Aggregates *versus* National Accounts

Figure 3.16 compares the firm size distribution in our dataset (left panel) against the aggregate distribution reported by the Central Business Registry for Spain (right panel).[18] Our dataset replicates well the aggregate firm size distribution and its time trends. For example, very small firms (with 1 or 2 employees) represent around 40% of the total number of active firms between 1995 and 2000. This share exhibits an upward trend in the post 2000 period (to reach 43.8% in 2007 and 48.5% in 2011). Our dataset captures this trend, though the share of very small firms is slightly over-represented in the final years of the sample (47.9% in 2007 and 52.1% in 2011).

---

[18] This is the distribution for the universe of firms with at least one worker.

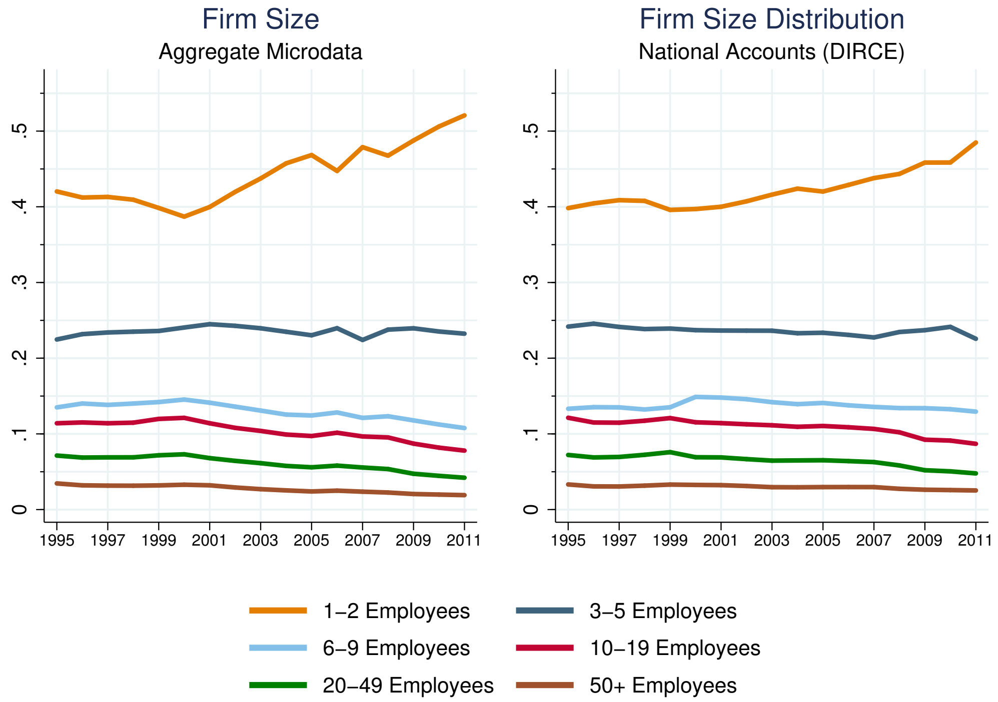


Figure 3.16: The Evolution of the Firm Size Distribution

Figure 3.17 performs a similar exercise for the distribution of employment: it compares the aggregate employment distribution in our dataset (left panel) against the full-economy aggregate distribution (right panel). Two aspects stand out. First, the employment share of large firms seems to be over-represented in our dataset for the initial years of the sample: in 1995 firms with 200 or more employees represent approximately 43.0% of total employment in the dataset, whereas the corresponding macroeconomic share is 33.8% (i.e. 9.2 pp lower). Second, this gaps practically disappears in 2002: firms with 200 or more employees account for 33.1% of total employment in DIRCE-SABI-CBI and 32.6% in the national accounts. Indeed, the employment distribution of our dataset replicates the national one quite closely after 2002: all five shares considered exhibit similar levels and trends with those reported in official statistics. Note that the share of the largest firms increases in the post-2000 period: firms with 200 or more employees represent 36% of total employment in 2013 (both in the dataset and in the economy).

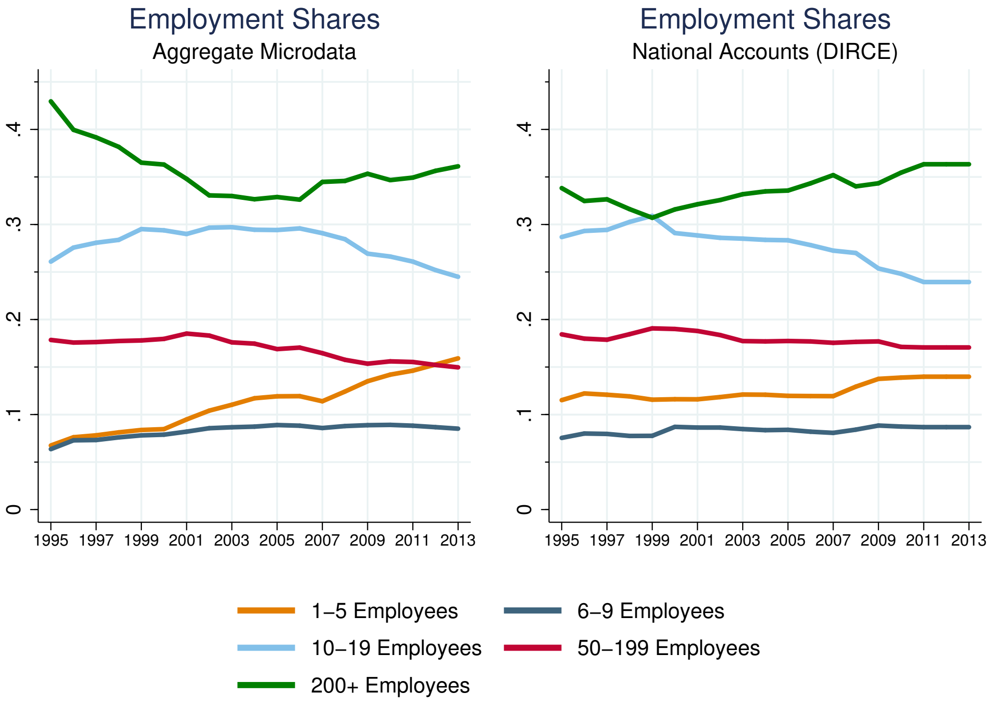


Figure 3.17: The Evolution of the Employment Distribution

3.5.2 Descriptive Statistics

The following table reports descriptive statistics for the DIRCE-SABI-CBI dataset by employment size bins (all values refer to the year 2005). The first columns show the total number of firms in the dataset, as well as the aggregate number of firms that entered and exited in 2005. Small firms (up to 5 employees) represent 69.1% of all firms in our dataset and account for respectively 77.9% and 82.6% of the aggregate numbers of entry and exit. The last columns show median values for total revenues, value added, the capital stock and wage per worker for each size class.

	Firms		Entry		Exit		Turnover	VA	Capital	Wage/Worker
Employment Size	Total (#)	Share (%)	Total (#)	Share (%)	Total (#)	Share (%)	Median (EUR)	Median (EUR)	Median (EUR)	Median (EUR)
$[1, 5]$	658,254	69.1	41,985	77.9	27,625	82.6	78,210	28,720	16,590	3,860
$[6, 9]$	119,666	12.6	6,474	12.0	2,890	8.6	265,810	149,930	69,880	16,594
$[10, 19]$	93,108	9.8	3,564	6.6	1,758	5.3	599,580	319,410	157,390	19,015
$[20, 49]$	53,152	5.6	1,500	2.8	764	2.3	1,624,710	808,530	442,540	21,420
$[50, 199]$	23,011	2.4	370	0.7	318	1.0	5,239,595	2,592,090	1,626,030	24,829
$[200, \infty)$	5,150	0.5	37	0.1	83	0.2	32,420,380	14,196,885	11,679,500	28,212
All	952,341	100	53,930	100	33,438	100	176,090	70,350	39,750	10,326

Year: 2005

3.6 Appendix: US Business Dynamism Indicators

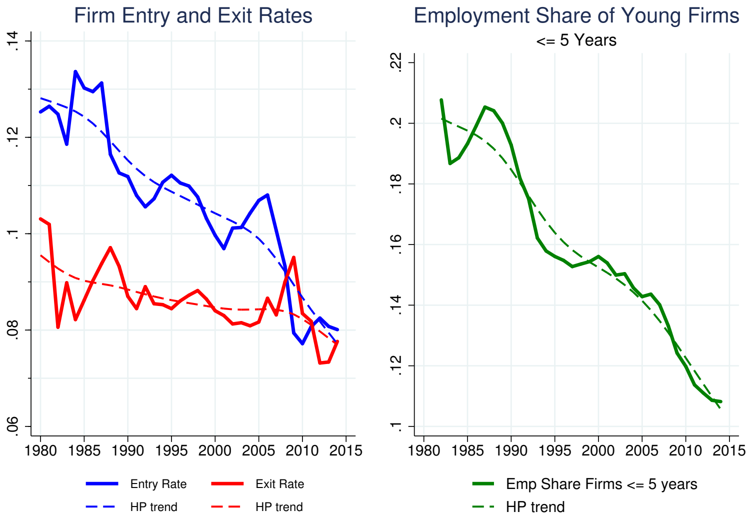


Figure 3.18: US Business Dynamism Indicators

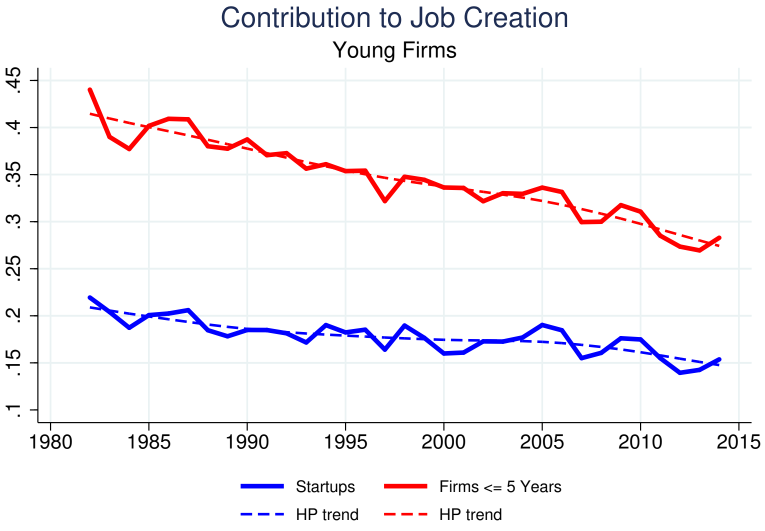


Figure 3.19: Share of US total job creation accounted for by young firms

3.7 Appendix: Firm Entry and Exit

3.7.1 1996-2013

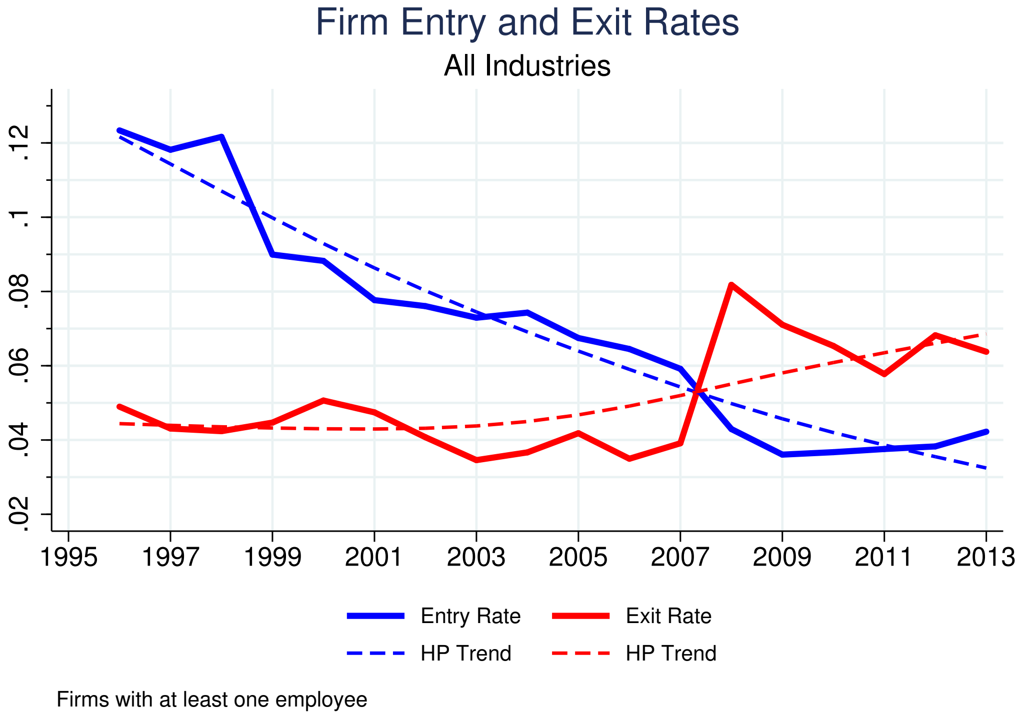


Figure 3.20: Firm Entry and Exit Rates: 1996-2013

After 2007, the startup rate declines further to 4.3% in 2008 and 3.6% in 2009; it then remains at round 4% in the subsequent years. The exit rate then jumps to 8.2% in 2008 (corresponding to the beginning of the great recession), but does not rebound to its pre-crisis trend thereafter. This fact is not surprising given than Spain was in a prolonged recession from 2008 to 2013. Furthermore, the Spanish Bankruptcy Law was changed twice in this period - a first time in 2009 and a second time in 2011 - with the objective of simplifying the processes of firm liquidation (García-Posada and Vegas [2016]).

3.7.2 All Firms

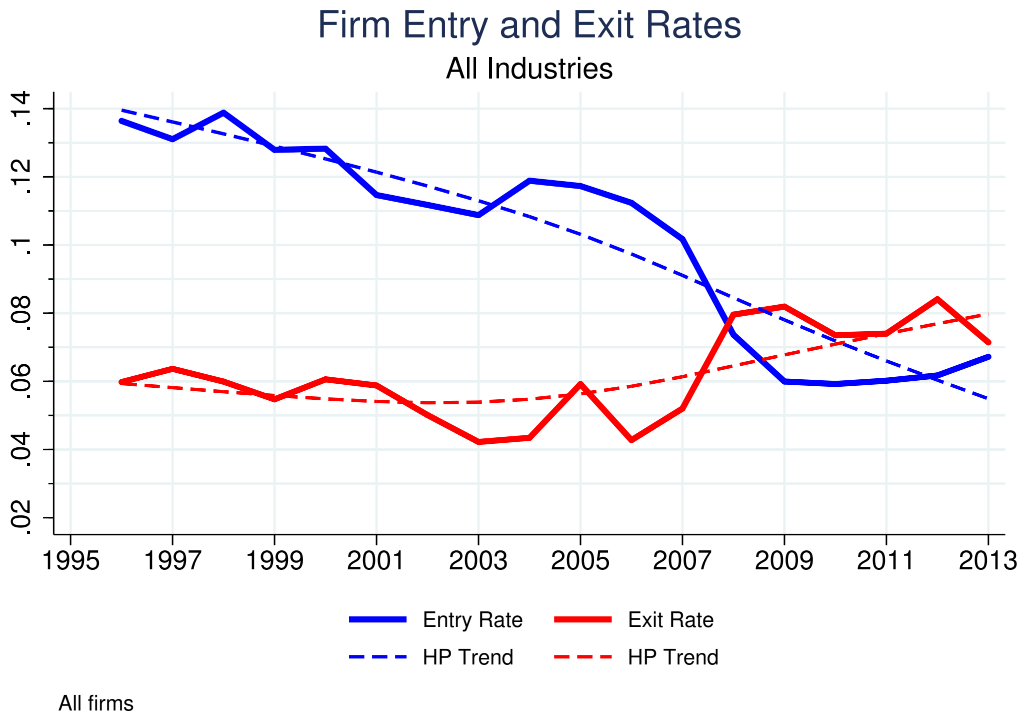


Figure 3.21: All Firms (including firms with zero employees)

3.7.3 Exclude Construction and Real Estate Sectors

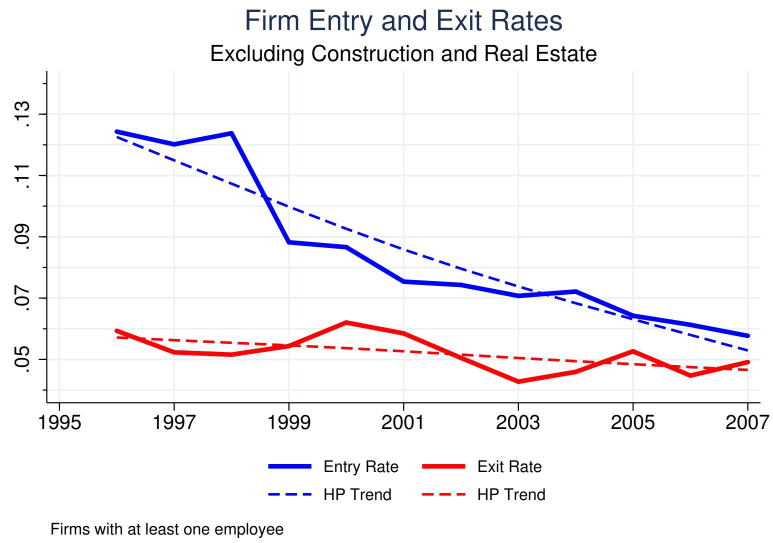


Figure 3.22: Firms with at least one employee

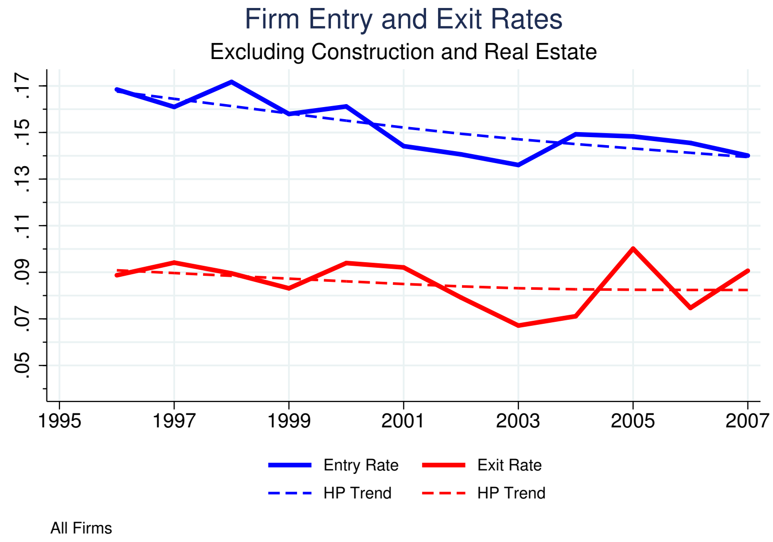


Figure 3.23: All Firms (including firms with zero employees)

3.7.4 Firm Entry and Exit (Numbers)

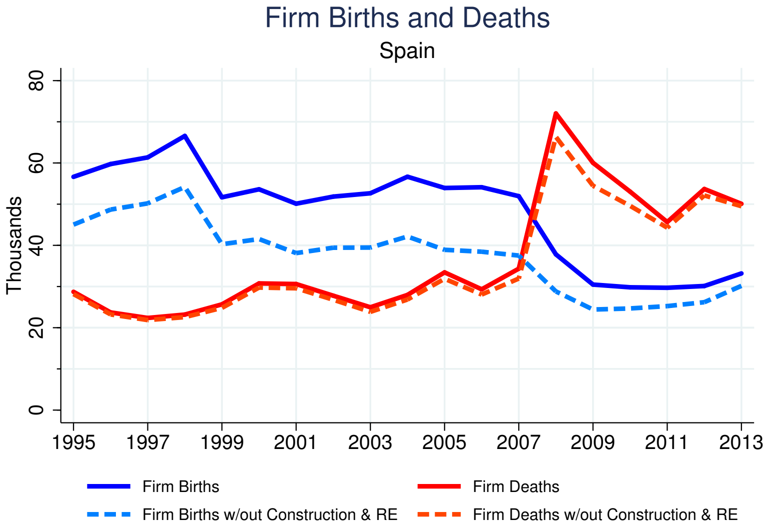


Figure 3.24: Numbers of Firms Entering and Exiting: Spain

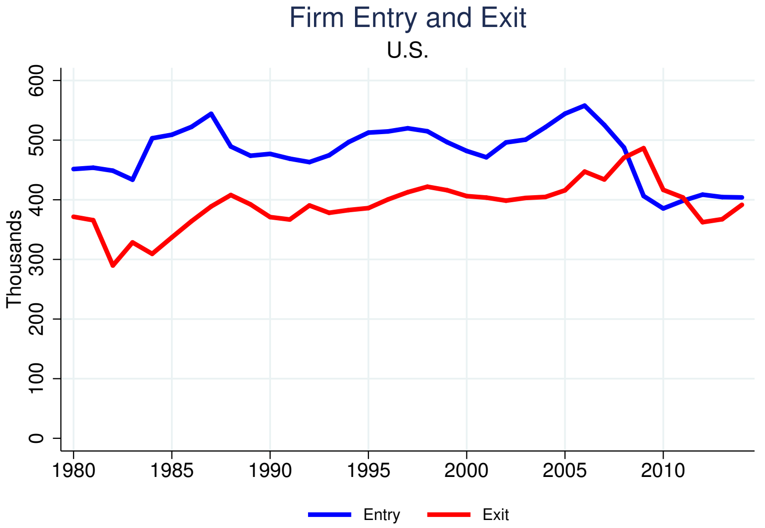


Figure 3.25: Numbers of Firms Entering and Exiting: US

3.7.5 Job Entry and Exit (Numbers)

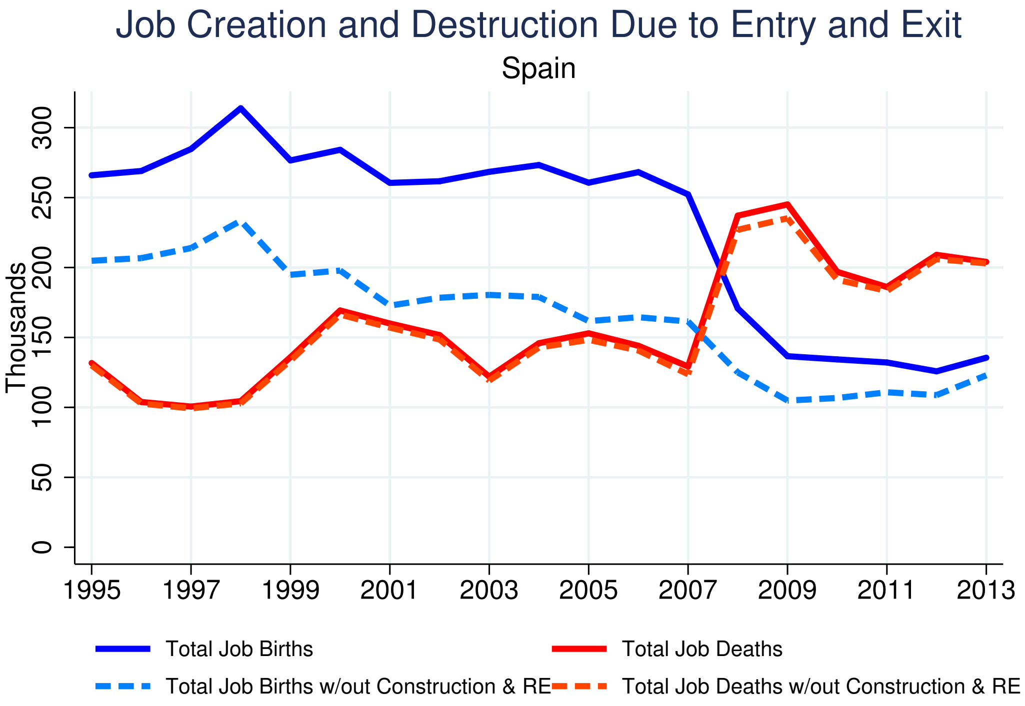


Figure 3.26: Job Creation and Destruction Due to Entry and Exit

3.7.6 Entry and Exit Rates: Microdatabase *versus* National Accounts

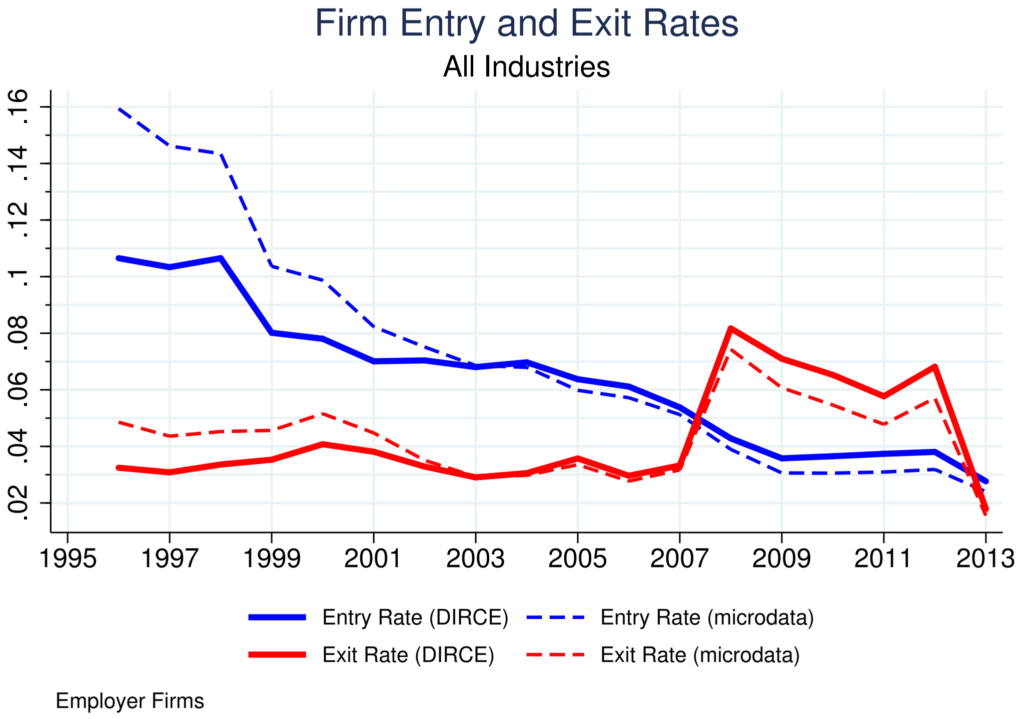


Figure 3.27: Entry and Exit Rates: Microdatabase vs National Accounts

3.7.7 Firm and Employment Shares of Young Firms

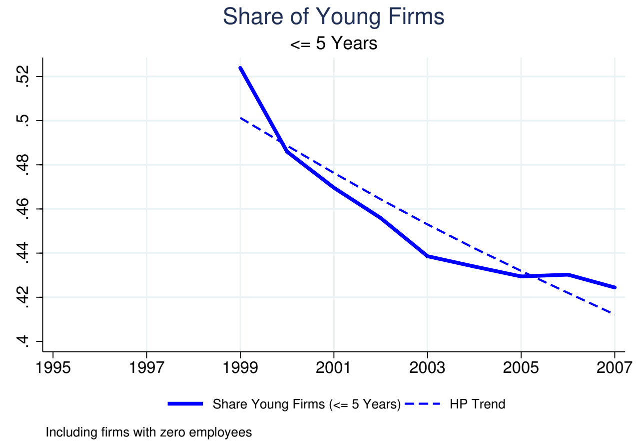


Figure 3.28: Share of Young Firms in the Total Number of Firms

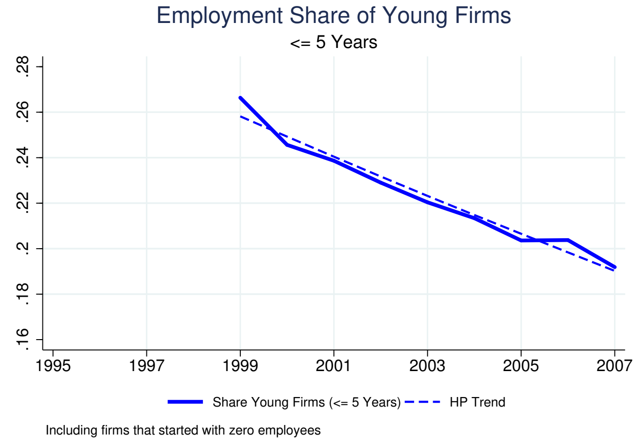


Figure 3.29: Employment Share of Young Firms

	U.S.			Spain		
	1999	2007	△ (2007-1999)	1999	2007	△ (2007-1999)
Number of Firms	0.416	0.399	-0.017	0.524	0.425	-0.099
Employment	0.154	0.140	-0.014	0.267	0.191	-0.076

Shares of Young Firms ($\leq$ 5 Years): US vs Spain

3.8 Appendix: Entrants-Incumbents RTFP Gap

Firms with 1-5 Employees

Entrants-Incumbents RTFP Gap: 1998-2007

	(1)	(2)	(3)	(4)	(5)
	All Industries	Manufacturing	Construction	Trade	Services
VARIABLES	rtfp$_{jit}$	rtfp$_{jit}$	rtfp$_{jit}$	rtfp$_{jit}$	rtfp$_{jit}$
α	-0.116***	-0.247***	-0.0803***	-0.114***	-0.0821**
	(0.0133)	(0.0232)	(0.0269)	(0.0146)	(0.0357)
β	0.0148***	0.0342***	0.00365	0.0212***	0.00907**
	(0.00293)	(0.00307)	(0.00825)	(0.00221)	(0.00397)
Observations	1,493,345	160,793	287,071	406,154	639,327
R-squared	0.681	0.441	0.056	0.507	0.782
Industry × Year FE	YES	YES	YES	YES	YES
Number of Industries	502	231	23	91	157

Industry-clustered standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Firms with 6-10 Employees

Entrants-Incumbents RTFP Gap: 1998-2007

	(1)	(2)	(3)	(4)	(5)
	All Industries	Manufacturing	Construction	Trade	Services
VARIABLES	rtfp$_{jit}$	rtfp$_{jit}$	rtfp$_{jit}$	rtfp$_{jit}$	rtfp$_{jit}$
α	-0.0940***	-0.136***	-0.0790***	-0.0783***	-0.0940***
	(0.00840)	(0.0125)	(0.0255)	(0.0129)	(0.0137)
β	0.00135	0.00775***	-0.00230	0.00414**	-0.000906
	(0.00141)	(0.00243)	(0.00195)	(0.00207)	(0.00230)
Observations	713,127	146,389	140,412	225,997	200,329
R-squared	0.733	0.647	0.082	0.702	0.801
Industry × Year FE	YES	YES	YES	YES	YES
Number of Industries	495	231	23	91	150

Industry-clustered standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Firms with 11-19 Employees

	Entrants-Incumbents RTFP Gap: 1998-2007				
	(1)	(2)	(3)	(4)	(5)
	All Industries	Manufacturing	Construction	Trade	Services
VARIABLES	rtfp_{jit}	rtfp_{jit}	rtfp_{jit}	rtfp_{jit}	rtfp_{jit}
α	-0.114***	-0.135***	-0.102***	-0.117***	-0.109***
	(0.00954)	(0.0172)	(0.0186)	(0.0203)	(0.0195)
β	0.00444***	0.00841***	-0.000128	0.0121***	0.00241
	(0.00155)	(0.00279)	(0.00125)	(0.00318)	(0.00269)
Observations	458,022	122,377	97,050	124,821	113,774
R-squared	0.751	0.692	0.067	0.717	0.799
Industry × Year FE	YES	YES	YES	YES	YES
Number of Industries	495	232	23	91	149

Industry-clustered standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Firms with 20+ Employees

	Entrants-Incumbents RTFP Gap: 1998-2007				
	(1)	(2)	(3)	(4)	(5)
	All Industries	Manufacturing	Construction	Trade	Services
VARIABLES	rtfp_{jit}	rtfp_{jit}	rtfp_{jit}	rtfp_{jit}	rtfp_{jit}
α	-0.126***	-0.153***	-0.105***	-0.161***	-0.0995***
	(0.0133)	(0.0239)	(0.0206)	(0.0350)	(0.0259)
β	0.00397**	0.00809**	-0.000710	0.0157***	-0.000185
	(0.00199)	(0.00361)	(0.00185)	(0.00511)	(0.00404)
Observations	455,555	153,553	90,948	96,355	114,699
R-squared	0.767	0.722	0.045	0.729	0.785
Industry × Year FE	YES	YES	YES	YES	YES
Number of Industries	496	231	23	91	151

Industry-clustered standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

3.9 Appendix: Capital-Labor Ratios and Capital Stocks

Capital-Labor Ratios Our model can explain how an interest rate decline may simultaneously generate (i) lower rates of firm entry and exit and (ii) a larger relative productivity of entrants. The mechanism hinged on the existence of credit constraints, that were assumed to be more prevalent across entrants. As discussed, unconstrained firms could take more advantage of the reduction in interest rates and increase their capital stock fast. Constrained firms on the other would see their capital stock grow more slowly. This translated into constrained firms having relatively lower capital-labor ratios. In this section we investigate whether this fact is also observed in the data. To do so, we consider the following regression

$$\log\left(\frac{\mathrm{k}_{ijt}}{\mathrm{l}_{ijt}}\right) = \alpha\cdot\underbrace{\text{entrant}_{ijt}}_{\in\{0,1\}} + \beta\cdot[(t-1998)\times\text{entrant}_{ijt}] + \theta_{it} + u_{ijt} \qquad t = 1998, ..., 2013 \tag{3.15}$$

where entrant_{ijt} is an indicator variable that takes value one if the firm is an entrant (and zero otherwise) and θ_{it} is an industry-time fixed effect. We include in the set of entrants all firms that are between 1 and 3 years. We are interested in the sign of the coefficient β, which measures the capital-labor ratio of entrants evolves with respect to that of incumbents of the same industry. The results are shown in the table below. The first column reports the coefficient estimates when all industries are included. The estimate of α is negative and significant, i.e. entrants have on average lower capital-labor ratios. The estimate of β is also negative and significant, meaning that over the period considered the difference becomes more important. The economic magnitudes are considerable. Indeed, in 1998 the average difference between the capital-labor ratio of entrants and incumbents was -0.233 (log points). In 2007, this gap was equal approximately equal to -0.399 (log points). As we can see in columns 2 to 5, this trend is observable in all four major sectors (Manufacturing, Construction, Trade and Services).

Entrants-Incumbents Capital-Labor Ratio Gap: 1998-2007

	(1)	(2)	(3)	(4)	(5)
	All Industries	Manufacturing	Construction	Trade	Services
VARIABLES	$\log\left(\frac{\text{k}_{jit}}{\text{l}_{jit}}\right)$	$\log\left(\frac{\text{k}_{jit}}{\text{l}_{jit}}\right)$	$\log\left(\frac{\text{k}_{jit}}{\text{l}_{jit}}\right)$	$\log\left(\frac{\text{k}_{jit}}{\text{l}_{jit}}\right)$	$\log\left(\frac{\text{k}_{jit}}{\text{l}_{jit}}\right)$
α	-0.233***	-0.0670***	-0.512***	-0.232***	-0.203***
	(0.0448)	(0.0213)	(0.139)	(0.0286)	(0.0693)
β	-0.0184***	-0.0109***	-0.0185**	-0.00685**	-0.0149*
	(0.00539)	(0.00336)	(0.00827)	(0.00314)	(0.00890)
Observations	3,114,934	578,447	608,759	851,067	1,076,661
R-squared	0.289	0.144	0.281	0.051	0.379
Industry × Year FE	YES	YES	YES	YES	YES
Number of Industries	513	232	23	91	167

Industry-clustered standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Capital Stock We also estimate 3.15, by using the (log) capital stock as the dependent variable. The estimate of β is also negative, though not always significant

Entrants-Incumbents Capital Stock Gap: 1998-2007

	(1)	(2)	(3)	(4)	(5)
	All Industries	Manufacturing	Construction	Trade	Services
VARIABLES	$\log\left(\text{k}_{jit}\right)$	$\log\left(\text{k}_{jit}\right)$	$\log\left(\text{k}_{jit}\right)$	$\log\left(\text{k}_{jit}\right)$	$\log\left(\text{k}_{jit}\right)$
α	-0.375***	-0.432***	-0.463***	-0.457***	-0.169*
	(0.0363)	(0.0345)	(0.0615)	(0.0409)	(0.0868)
β	-0.00553	-0.00118	-0.0186**	0.00578	-0.0156*
	(0.00544)	(0.00473)	(0.00693)	(0.00410)	(0.00853)
Observations	3,172,214	584,429	624,965	857,108	1,105,712
R-squared	0.165	0.134	0.117	0.066	0.226
Industry × Year FE	YES	YES	YES	YES	YES
Number of Industries	513	232	23	91	167

Industry-clustered standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

3.10 Appendix: Concentration

Wee document the evolution of two indicators of industry concentration: (i) the share of the 4, 10 and 20 largest firms in each 4-digit industry and (ii) Herfindahl-Hirschman indexes of concentration.[19] Figure 3.30 plots a weighted average share of the 4, 10 and 20 largest firms across 4-digit industries; we use fixed industry weights that correspond to each industry's contribution in aggregate value added. The left panel reports the results for revenues (or output), whereas the right panel focuses on employment. As we see in Figure 3.30, there is a downward trend in the share of each industry's largest firms. Note that the results for the 1995-2000 period should be interpreted with caution, as the coverage of the dataset increases during this period. However, even when focusing on the 2001-2007 period (when coverage is constant both for gross output and employment) there seems to be a decline in concentration. Between 2001 and 2007, the weighted-average market share of the 4 largest firms falls from 33.2% to 31.9%, whereas the share of the 20 largest firms experiences a decline from 52.9% to 50.8%. When looking at employment, there is a similar trend: the share of the 4 largest firms declines from 26.5% to 25.8%, and the share of the 20 largest firms falls from 44.1% to 42.2%.

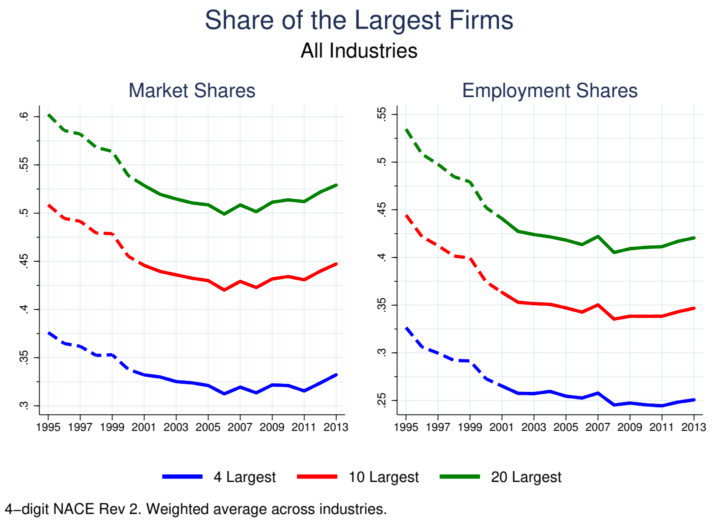
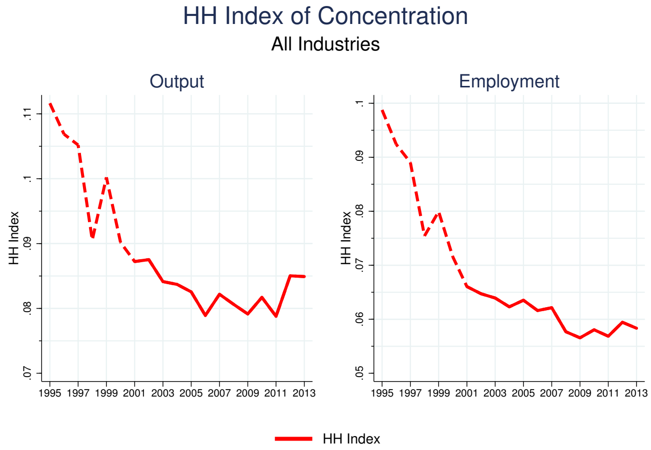


Figure 3.30: Industry Concentration: Shares of the Largest Firms

---

[19] All industries with a minimum number of firms equal or less than 20 were excluded.

Figure 3.31 reports the evolution of Herfindahl-Hirschman indexes of concentration. This index is constructed as the sum of the squares of the market shares of the firms within a given industry. It can vary from 0 (perfect competition) to 1 (monopoly), with a higher index reflecting higher concentration. The results shown in Figure 3.31 also point to a decline in concentration between 2001-2007.


HH Index of Concentration
All Industries

Output

Employment

4–digit NACE Rev 2. Weighted average across industries.

Figure 3.31: Industry Concentration: HH Index

Finally, the following reports all the above measures of concentration for four major sectors (Manufacturing, Construction, Trade and Services) in 2001 and in 2007. We can observe a generalized decline in concentration in all four sectors, the results being particularly strong for Trade and for Services.

Concentration by Sector (Output): 2001-2007

	Share 4 Largest			Share 20 Largest			HH Index		
	2001	2007	Δ_{01-07}	2001	2007	Δ_{01-07}	2001	2007	Δ_{01-07}
Total Economy	0.332	0.319	-0.013	0.529	0.508	-0.021	0.087	0.087	-0.005
Manufacturing	0.360	0.354	-0.006	0.624	0.620	-0.004	0.0690	0.071	0.002
Construction	0.167	0.147	-0.020	0.278	0.261	-0.017	0.031	0.018	-0.013
Trade	0.301	0.284	-0.017	0.482	0.454	-0.028	0.075	0.072	-0.003
Services	0.335	0.312	-0.023	0.515	0.481	-0.034	0.110	0.097	-0.014

Data is from DIRCE and SABI-CBI 1995-2013.

3.11 Appendix: The Model with no Financial Frictions

In the absence of financial frictions, all firms are unconstrained. In such case, the value of a firm with idiosyncratic productivity φ that decides not to exit is given by

$$V(\varphi) = \frac{1}{R}\Big\{\pi(\varphi) + \underbrace{(1-\lambda)\,V(\varphi) + \lambda\cdot V_0}_{\text{continuation value}}\Big\}$$

This equation says that the value of an active firm has two components. The first consists of the monopoly profits $\pi(\varphi)$ that the firm makes in the following period. The second is the continuation value. With probability $1-\lambda$ the firm keeps its productivity unchanged and hence has the same value $V(\varphi)$. With probability λ, the firm makes a new productivity draw and has a value that coincides with that of being an entrant V_0 (after paying the entry cost).

$$V(\varphi) = 0 \Leftrightarrow \underline{\varphi} = \left[\frac{1-\rho}{c_f - \lambda\cdot V_0}Y\right]^{\frac{\rho}{1-\rho}}\frac{q}{\rho} \tag{3.16}$$

where $q := \left(\frac{W}{1-\alpha}\right)^{1-\alpha}\left[\frac{R-(1-\delta)}{\alpha}\right]^{\alpha}$. We may therefore write the value of a firm with productivity φ as

$$V(\varphi) = \begin{cases} 0 & \text{if} \quad \varphi < \underline{\varphi} \\ \dfrac{\pi(\varphi) + \lambda V_0}{R-(1-\lambda)} & \text{if} \quad \varphi \geq \underline{\varphi} \end{cases}$$

We solve for a stationary equilibrium. We need to determine five endogenous variables: aggregate output (Y), the wage rate (W), the exit cutoff ($\underline{\varphi}$), the number of active firms (M) and the number of firms paying the entry cost in every period (n). We next derive the five equilibrium conditions that characterize a stationary equilibrium of our model.

Output Market Equilibrium In equilibrium, total output Y must equal aggregate revenues

$$Y = M\cdot\int_{\underline{\varphi}}^{\infty} r(\varphi)\cdot\frac{f(\varphi)}{1-F(\underline{\varphi})}\,d\varphi$$

Labor Market Equilibrium We assume that there is a constant labor supply L. Labor market clearing therefore requires that total labor supply equals total labor demand

$$L = M \cdot \int_{\underline{\varphi}}^{\infty} l(\varphi) \cdot \frac{f(\varphi)}{1 - F\left(\underline{\varphi}\right)} \, d\varphi$$

Free Entry Condition Since there is a large and unbounded mass of prospective entrants, the marginal firm paying the entry cost cannot make positive profits in expectation, i.e.

$$\underbrace{\int_{\underline{\varphi}}^{\infty} V(\varphi) \cdot f(\varphi) \; d\varphi}_{V_0} = c_e(n)$$

where n denotes the number of firms paying the entry cost.

Entry and Exit In a stationary equilibrium, the number of exiting firms must equal the number of new active firms. This means that

$$\underbrace{F\left(\underline{\varphi}\right) \cdot \lambda \cdot M}_{\text{exit}} = \underbrace{\left[1 - F\left(\underline{\varphi}\right)\right] \cdot n}_{\text{entry}}$$

Note that the number of exiting firms corresponds to the number of active firms making a new productivity draw that is below the threshold $\underline{\varphi}$. Recall that a fraction λ of all active firms are forced to draw a new productivity level and, among these, a fraction $F\left(\underline{\varphi}\right)$ draws a value $\varphi < \underline{\varphi}$. The number of new active corresponds to the number of firms paying the entry cost and making a productivity draw above $\underline{\varphi}$.

Endogenous Exit Decision Firms will exit whenever their idiosyncratic productivity level is below the threshold $\underline{\varphi}$, which is equal to

$$\underline{\varphi} = \left[\frac{Rc_f - \lambda \cdot V_0}{(1-\rho) Y}\right]^{\frac{1-\rho}{\rho}} \frac{q}{\rho}$$

Equilibrium Characterization

Provided that $\nu\frac{1-\rho}{\rho} > 1$ all above integrals are well defined and finite. First, note that the free entry condition implies that

$$\int_{\underline{\varphi}}^{\infty} \frac{1}{R-(1-\lambda)} \left\{(1-\rho)\left(\frac{\rho\varphi}{q}\right)^{\frac{\rho}{1-\rho}} Y - Rc_f + \lambda c_e\right\} \nu\varphi^{-(\nu+1)}\, d\varphi = c_e$$

$$\Leftrightarrow (1-\rho)\left(\frac{\rho}{q}\right)^{\frac{\rho}{1-\rho}} Y \frac{\nu(1-\rho)}{\nu(1-\rho)-\rho}\underline{\varphi}^{\frac{\rho}{1-\rho}-\nu} + (\lambda c_e - Rc_f)\,\underline{\varphi}^{-\nu} = [R-(1-\lambda)]\, c_e$$

Note that we also have that

$$\underline{\varphi} = \left[\frac{Rc_f - \lambda V_0}{(1-\rho)\,Y}\right]^{\frac{1-\rho}{\rho}} \frac{q}{\rho}$$

$$\Leftrightarrow Y\left(\frac{\rho}{q}\right)^{\frac{\rho}{1-\rho}} = \left(\frac{Rc_f - \lambda \cdot V_0}{1-\rho}\right)\underline{\varphi}^{-\frac{\rho}{1-\rho}}$$

Combining the two

$$(1-\rho)\left(\frac{Rc_f - \lambda c_e}{1-\rho}\right)\underline{\varphi}^{-\frac{\rho}{1-\rho}} \frac{\nu(1-\rho)}{\nu(1-\rho)-\rho}\underline{\varphi}^{\frac{\rho}{1-\rho}-\nu} + (\lambda c_e - Rc_f)\,\underline{\varphi}^{-\nu} = [R-(1-\lambda)]\, c_e$$

$$\Leftrightarrow \underline{\varphi} = \left\{\frac{Rc_f - \lambda c_e}{[R-(1-\lambda)]\, c_e}\frac{\rho}{\nu(1-\rho)-\rho}\right\}^{\frac{1}{\nu}}$$

We therefore have that

$$\frac{\partial}{\partial R} > 0 \Leftrightarrow c_f\,[R-(1-\lambda)]\, c_e > c_e\,[Rc_f - \lambda c_e] \Leftrightarrow c_f < \frac{\lambda}{1-\lambda}c_e$$

We can determine equilibrium output

$$Y\left(\frac{\rho}{q}\right)^{\frac{\rho}{1-\rho}} = \left(\frac{Rc_f - \lambda \cdot V_0}{1-\rho}\right)\underline{\varphi}^{-\frac{\rho}{1-\rho}}$$

$$\Leftrightarrow Y^{1-(1-\alpha)\frac{\rho}{1-\rho}} = \left\{\left(\frac{\rho}{L}\right)^{1-\alpha}\left[\frac{R-(1-\delta)}{\alpha}\right]^{\alpha}\right\}^{\frac{\rho}{1-\rho}}\left(\frac{Rc_f - \lambda c_e}{1-\rho}\right) \times$$

$$\times \left\{\frac{Rc_f - \lambda c_e}{[R-(1-\lambda)]\, c_e}\frac{\rho^{1+\nu}}{\nu(1-\rho)-\rho}\right\}^{-\frac{\rho}{1-\rho}\frac{1}{\nu}}$$

Bibliography

[1] Aghion, P. and J. Stein (2008), “Growth versus Margins: Destabilizing Consequences of Giving the Stock Market What It Wants,” *Journal of Finance* 63(3), 1025–1058.

[2] Almunia, M., D. López-Rodríguez and E. Moral-Benito (2016), “Using Firm-Level Data to Build a Macro-Representative Micro-Dataset: An Application for the Spanish Economy,” *Mimeo.*

[3] Autor, D., D. Dorn, L. Katz, C. Patterson and J. Van Reenen (2017), “The Fall of the Labor Share and the Rise of Superstar Firms,” NBER Working Paper 23396.

[4] Baker, M., J. Stein and J. Wurgler (2003), “When Does the Market Matter? Stock Prices and the Investment of Equity-Dependent Firms,” *The Quarterly Journal of Economics* 118(3), 969–1005.

[5] Bijnens, G. and and J. Konings (2017), “Where Has the Belgian Business Dynamism Gone? The Decline in High Growth (Small) Firms,” *Working Paper.*

[6] Blanchard, O., C. Rhee and L. Summers (1993), “The Stock Market, Profit, and Investment,” *The Quarterly Journal of Economics* 108(1), 115-136.

[7] Bowen, R., A. Davis and S. Rajgopal (2002), “Determinants of Revenue-Reporting Practices for Internet Firms,” *Contemporary Accounting Research* 19(4), 523–562.

[8] Brunnemeier, M. and S. Nagel (2004), "Hedge Funds and the Technology Bubble," *The Journal of Finance* 59(5), 2013–2040.

[9] Caballero, R. and A. Krishnamurthy (2006), "Bubbles and Capital Flow Volatility: Causes and Risk Management," *Journal of Monetary Economics* 53(1), 33–53.

[10] Caggese, A. and V. Cuñat (2013), "Financing Constraints, Firm Dynamics, Export Decisions and Aggregate Productivity," *Review of Economic Dynamics* 16(1), 177–193.

[11] Calvino, F., C. Criscuolo and C. Menon (2015), "Cross-Country Evidence on Start-Up Dynamics," *OECD Working Paper.*

[12] Campbell, J. and R. Shiller (1987), "Cointegration and Tests of Present Value Models," *Journal of Political Economy* 95(5), 1062–1088.

[13] Campbell, J. and R. Shiller (1988a), "The Dividend-Price Ratio and Expectations of Future Dividends and Discount Factors," *The Review of Financial Studies* 1(3), 195–228.

[14] Campbell, J. and R. Shiller (1988b), "Stock Prices, Earnings and Expected Dividends," *The Journal of Finance* 43(3), 661–676.

[15] Campbell, G. and J. Turner (2010), "'The Greatest Bubble in History': Stock Prices during the British Railway Mania," MPRA Paper 21820, University Library of Munich.

[16] Campbell, G. and J. Turner (2012), "Dispelling the Myth of the Naive Investor during the British Railway Mania, 1845–1846," *Business History Review* 86(1), 3–41.

[17] Campbell, G. and J. Turner (2015), "Managerial Failure in Mid-Victorian Britain?: Corporate Expansion During a Promotion Boom," *Business History*, 57(8), 1248–1276.

[18] Campello, M. and J. Graham (2013), "Do Stock Prices Influence Corporate Decisions? Evidence from the Technology Bubble," *Journal of Financial Economics* 107(1), 89–110.

[19] Carvalho, V. and B. Grassi (2015), "Large Firm Dynamics and the Business Cycle," *Working Paper.*

[20] Carvalho, V., A. Martin and J. Ventura (2012), "Understanding Bubbly Episodes," *American Economic Review Papers & Proceedings* 102(3), 95–100.

[21] Chevalier, J. and D. Scharfstein (1996), "Capital-Market Imperfections and Countercyclical Markups: Theory and Evidence," *American Economic Review* 86(4), 703–725.

[22] Chirinko, R., and H. Schaller (2001), "Business Fixed Investment and "Bubbles": The Japanese Case," *American Economic Review* 91(3), 663–680.

[23] Chirinko, R. and H. Schaller (2011), "Fundamentals, Misvaluation, and Business Investment," *Journal of Money, Credit and Banking* 43(7), 1423–1442.

[24] Clementi, G. L. and H. Hopenhayn (2006), "A Theory of Financing Constraints and Firm Dynamics," *The Quarterly Journal of Economics* 121(1), 229–265.

[25] Clementi, G. L. and B. Palazzo (2016), "Entry, Exit, Firm Dynamics, and Aggregate Fluctuations," American Economic Journal: Macroeconomics 8(3), 1–41.

[26] Cooley, T. and V. Quadrini (2001), "Financial Markets and Firm Dynamics," *American Economic Review* 91(5), 1286–1310.

[27] Cooper, M., O. Dimitrov and P. Raghavendra Rau (2001), "A Rose.com by Any Other Name," *The Journal of Finance* 56(6), 2371–2388.

[28] Cotterill, C. F. (1849), "The Past, Present, and Future Position of The London and North Western, and Great Western Railway Companies," London: Effingham Wilson.

[29] Davis, S. and J. Haltiwanger (2014), "Labor Market Fluidity and Economic Performance," Federal Reserve Bank of Kansas City Jackson Hole Symposium, *Re-Evaluating Labor Market Dynamics*, 17–107.

[30] Decker, R., J. Haltiwanger, R. Jarmin and J. Miranda (2014a), "The Role of Entrepreneurship in US Job Creation and Economic Dynamism," *Journal of Economic Perspectives* 28(3), 3–24.

[31] Decker, R., J. Haltiwanger, R. Jarmin and J. Miranda (2014b), "The Secular Decline in Business Dynamism in the U.S.," *Working Paper.*

[32] Decker, R., J. Haltiwanger, R. Jarmin and J. Miranda (2017), "Changing Business Dynamism and Productivity: Shocks vs. Responsiveness," *Working Paper.*

[33] De Loecker, J. and J. Eeckhout (2017), "The Rise of Market Power and the Macroeconomic Implications," NBER Working Paper 23687.

[34] Diamond, P. (1958), "National Debt in a Neoclassical Growth Model," *American Economic Review* 55(5), 1126–1150.

[35] Engbom, N. (2017), "Firm and Worker Dynamics in an Aging Labor Market," *Working Paper.*

[36] Farhi, E. and J. Tirole (2011), "Bubbly Liquidity," *Review of Economic Studies* 79(2), 678–706.

[37] Foster, L., J. Haltiwanger and C. Krizan (2006), "Market Selection, Reallocation, and Restructuring in the U.S. Retail Trade Sector in the 1990s," *The Review of Economics and Statistics*, 88(4), 748–758.

[38] Foster, L., J. Haltiwanger and C. Syverson (2008), "Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability?," *American Economic Review*, 98(1), 394–425.

[39] Froot, K. and E. Dabora (1999), "How Are Stock Prices Affected by Location of Trade?," *Journal of Financial Economics* 53(2), 189–216.

[40] Froot, K. and M. Obstfeld (1991), "Intrinsic Bubbles: The Case of Stock Prices," *American Economic Review* 81(5), 1189–1214.

[41] Galí, Jordi (2017), "Monetary Policy and Bubbles in a New Keynesian Model with Overlapping Generations," *Mimeo*, Universitat Pompeu Fabra.

[42] Garber, P. (1989), "Tulipmania," *The Journal of Political Economy* 97(3), 535–560.

[43] García-Posada, M., and R. Vegas (2016), "Las Reformas de la Ley Concursal Durante la Gran Recesión," *Working Paper* 1610, Bank of Spain.

[44] García-Santana, M., E. Moral-Benito, J. Pijoan-Mas and R. Ramos (2016), "Growing like Spain: 1995-2007," *Working Paper.*

[45] Gilchrist, S., C. Himmelberg and C. Huberman (2005), "Do Stock Price Bubbles Influence Corporate Investment?," *Journal of Monetary Economics* 52(4), 805–827.

[46] Goldfarb, D. and B. Kirsch (2008), "Small Ideas, Big Ideas, Bad Ideas, Good Ideas: "Get Big Fast" and Dot Com Venture Creation," *The Internet and American Business*, Cambridge: MIT Press.

[47] Goldschlag, N. and A. Tabarrok (2018), "Is Regulation to Blame for the Decline in American Entrepreneurship?," *Economic Policy* 33(93), 5–44.

[48] Gopinath, G., S. Kalemli-Ozcan, L. Karabarbounis and C. Villegas-Sanchez (2017), "Capital Allocation and Productivity in South Europe," *The Quarterly Journal of Economics,* 132(4), 1915–1967.

[49] Griffin, J., J. Harris, T. Shu, and S. Topaloglu (2011), "Who Drove and Burst the Tech Bubble?," *The Journal of Finance* 56(4), 1251–1290.

[50] Grossman, G. and N. Yanagawa (1993), "Asset Bubbles and Endogenous Growth," *Journal of Monetary Economics* 31(1), 3–19.

[51] Haacke, C. (2004), "Frenzy: Bubbles, Busts and How to Come Out Ahead," Palgrave Macmillan.

[52] Haltiwanger, J. (2015), "Top Ten Signs of Declining Business Dynamism and Entrepreneurship in the U.S.," *Working Paper.*

[53] Hirano, T. and N. Yanagawa (2017), "Asset Bubbles, Endogenous Growth, and Financial Frictions," *Review of Economic Studies* 84(1), 406–443.

[54] Hong, H. and J. Stein (2003), "Simple Forecasts and Paradigm Shifts," NBER Working Paper 10013.

[55] Hopenhayn, H. (1992), "Entry, Exit, and Firm Dynamics in Long Run Equilibrium," *Econometrica* 60(5), 1127–1150.

[56] Jackman, W. T. (1916), "The Development of Transportation in Modern England," Volume II, Cambridge University Press.

[57] Karahan, F., B. Pugsley and A. Şahin (2016), "Demographic Origins of the Startup Deficit," *Working Paper.*

[58] Kim, M. and J. Ritter (1999), "Valuing IPOs," *Journal of Financial Economics* 53(3), 409–37.

[59] King, I. and D. Ferguson (1993), "Dynamic Inefficiency, Endogenous Growth , and Ponzi Games," *Journal of Monetary Economics* 32(1), 79–104.

[60] Kiyotaki, N., and J. Moore (1997), "Credit Cycles," *Journal of Political Economy* 105(2), 211–248.

[61] Kocherlakota, N. (2009), "Bursting Bubbles: Consequences and Cures," Mimeo, Federal Reserve Bank of Minneapolis.

[62] Lamont, O. and R. Thaler (2003), "Can the Market Add and Subtract? Mispricing in Tech Stock Carve-outs," *Journal of Political Economy* 111(2), 227–268.

[63] LeRoy, S. (1989), "Efficient Capital Markets and Martingales," *Journal of Economic Literature* 27(4), 1583–1621.

[64] LeRoy, S. (2004), "Rational Exuberance," *Journal of Economic Literature* 42(3), 783–804.

[65] LeRoy, S. and R. Porter (1981), "The Present-Value Relation: Tests Based on Implied Variance Bounds," *Econometrica* 49(3), 555–574.

[66] Liu, J., D. Nissin and J. Thomas (2002), "Equity Valuation Using Multiples," *Journal of Accounting Research* 40(1), 135-172.

[67] Martin, A. and J. Ventura (2011), "Theoretical Notes on Bubbles and the Current Crisis," *IMF Economic Review* 59(1), 6–40.

[68] Martin, A. and J. Ventura (2012), "Economic Growth with Bubbles," *American Economic Review* 102(6), 3033–3058.

[69] Martin, A. and J. Ventura (2016), "Managing Credit Bubbles," *Journal of the European Economic Association* 14(3), 753–789.

[70] Martin, R. M. (1849), "Railways – Past, Present, & Prospective," London: W.H. Smith and Son.

[71] Mas, M., F. Pérez, and E. Uriel (2013), "Inversión y Stock de Capital en España (1964-2011). Evolución y Perspectivas del Patrón de Acumulación," *Bilbao: Fundación BBVA*.

[72] Melitz, M. (2003), "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, 71(6), 1695–1725.

[73] Miao, J. and P. Wang (2012), "Bubbles and Total Factor Productivity," *American Economic Review Papers & Proceedings* 102(3), 82–87.

[74] Miller, M. and F. Modigliani (1961), "Dividend Policy, Growth and the Valuation of Shares," *The Journal of Business* 34(4), 411–433.

[75] Montero, J. and A. Urtasun (2014), "Price-Cost Mark-ups in the Spanish Economy: a Microeconomic Perspective," *Working Paper* 1407, Bank of Spain.

[76] Odlyzko, A. (2010), "Collective Hallucinations and Inefficient Markets: The British Railway Mania of the 1840s," Mimeo, University of Minnesota.

[77] Ofek, A. and M. Richardson (2002), "The Valuation and Market Rationality of Internet Stock Prices," *Oxford Review of Economic Policy* 18(3), 265–287.

[78] Ofek, A. and M. Richardson (2003), "DotCom Mania: The Rise and Fall of Internet Stock Prices," *The Journal of Finance* 58(3), 1113–1137.

[79] Olivier, P. (2000), "Growth-Enhancing Bubbles," *International Economic Review* 41(1), 133–151.

[80] Pagano, M., Panetta, F. and L. Zingales (1998), "Why Do Companies Go Public? An Empirical Analysis," *The Journal of Finance* 53(1), 27–64.

[81] Pastor, L. and P. Veronesi (2006), "Was There a Nasdaq Bubble in the Late 1990s?," *Journal of Financial Economics* 81(1), 61–100.

[82] Pastor, L. and P. Veronesi (2009), "Technological Revolutions and Stock Prices," *American Economic Review* 99(4), 1451–83.

[83] Polk, C. and P. Sapienza (2009), "The Stock Market and Corporate Investment: A Test of Catering Theory," *The Review of Financial Studies* 22(1), 187–217.

[84] Pugsley, B. and A. Şahin (2015), "Grown-Up Business Cycles," *Federal Reserve Bank of New York Staff Reports.*

[85] Razi, M., F. Siddiqui and J. Tarn (2004), "Exploring the Failure and Success of DotComs," *Information Management & Computer Securit*y 12(3), 228–244.

[86] Rotemberg, J. and M. Woodford (1992), "Oligopolistic Pricing and the Effects of Aggregate Demand on Economic Activity," *Journal of Political Economy* 100(6), 1153–1207.

[87] Samuelson, P. (1958), "An Exact Consumption-loan Model of Interest with or without the Social Contrivance of Money," *Journal of Political Economy* 66(6), 467–482.

[88] Shiller, R. (1981), “Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends?,” *American Economic Review* 71(3), 421–436.

[89] Shiller, R. (2000), “Irrational Exuberance,” Princeton University Press.

[90] Shiller, R. (2003), “From Efficient Markets Theory to Behavioral Finance,” *Journal of Economic Perspectives* 17(1), 83–104.

[91] Shiller, R. (2007), “Understanding Recent Trends in House Prices and Homeownership,” *Proceedings - Economic Policy Symposium - Jackson Hole, Federal Reserve Bank of Kansas City*, 89–123.

[92] Tang, Haozhou (2017), “Asset Price Bubbles and the Distribution of Firms: A Theory of Economic Expansions with an Application to Spain,” *Mimeo*, Universitat Pompeu Fabra.

[93] Tirole, J. (1985), “Asset Bubbles and Overlapping Generations,” *Econometrica* 53(6), 1499–1528.

[94] Umar, A. (2004), “Mobile Computing and Wireless Communications,” NGE Solutions.

[95] Varian, H. (2003), “Economics of Information Technology,” Mimeo, Univeristy of California, Berkeley.

[96] Ventura, J. (2011), “Bubbles and Capital Flows,” *Journal of Economic Theory* 147(2), 738–758.

[97] Xiong, W. and J. Yu (2011), “The Chinese Warrants Bubble,” *American Economic Review*, 101(6), 2723–53.

[98] Wooldridge, J. (2009), “Introductory Econometrics: A Modern Approach,” South-Western College Publishing, Fourth Edition.