Essays on the Macroeconomic Effects of Credit Market Fluctuations

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To my parents for their unwavering, long-distance faith.

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Abstract

This dissertation includes three chapters on the macroeconomic effects of the financial system, particularly the credit market. In the first chapter, I show a causal link between household credit supply and economic activity using an exogenous shock to household credit supply by Spanish banks in Mexico resulting from macroprudential regulations in Spain. I use the variation in exposure to this shock across Mexican municipalities as a natural experiment and measure the elasticity of lending to the non-tradable sector to changes in household credit ranging from 1.6-3.5. In the second chapter, I show that the Spanish regulations did not affect lending to Mexican firms by Spanish banks. I use firm-level data to show that firms with multiple bank relationships did not experience a change in loan-terms (in levels and interest rates) of marginal credit offered by Spanish banks vis-a-vis the terms offered by non-Spanish banks. I write a theoretical model that accounts for the asymmetric effect of the Spanish regulations on lending to firms and households based on the relationship rents earned by banks depending upon the proprietary information held by them on a given borrower. In the third chapter, I study the effect of asset bubbles in the presence of financial frictions and heterogeneous projects. I consider an economy with two sectors - a productive, financially constrained sector and an unproductive sector with lower levels of financial constraints. Financial constraints create conditions for the existence of asset bubbles. Asset bubbles, in turn, raise interest rates and lower investment productivity by directing financial resources away from the financially constrained, productive sector to the less constrained, unproductive sector. Such bubbles guide the economy to steady states with low levels of consumption that I call *bubbly growth traps*.

Resumen

Esta tesis incluye tres capítulos sobre el efecto macroeconómico de la sistema financiera, particularmente de los mercados de crédito. En el primer capítulo, muestro un vínculo causal entre la oferta del crédito a los hogares y la actividad económica usando un shock exógeno a la oferta de crédito a los hogares emitido por bancos Españoles debido a regulaciones marco-prudenciales en España. Uso la variación en la

exposición al shock entre municipios mexicanos como un experimento natural y mido la elasticidad del crédito al sector de bienes no comerciables a los cambios en crédito a los hogares entre 1.6-3.5. En el segundo capítulo, muestro que la regulación española no afecto a los préstamos a los negocios mexicanos concedidos por bancos españoles. Uso datos a nivel de empresa para mostrar que los negocios con relaciones comerciales con más de un banco no sufrieron cambios en los términos del préstamo del crédito marginal (en volumen y tipo de interés medio) emitidos por bancos españoles frente a los términos ofrecidos por bancos no españoles. Escribo un modelo teórico que ilustra el efecto asimétrico de las regulaciones españolas sobre los préstamos a las empresas y los hogares basado en la calidad de la información que tiene el banco sobre los diferentes deudores. En el tercer capítulo, estudio el efecto de las burbujas financieras cuando existen proyectos de inversión heterogéneos y limitaciones financieras. Considero una economía con dos sectores – un sector productivo con altas limitaciones financieras y otro sector menos productivo con bajas limitaciones financieras. Las limitaciones financieras crean las condiciones para que existan burbujas financieras. Estas burbujas, a su vez, aumentan los tipos de interés y disminuyen la productividad de las inversiones desviando fondos de los sectores más productivos, sujetos a altas limitaciones financieras, a los sectores menos productivos. Estas burbujas guían la economía a estados estacionarios con niveles bajos de consumo que denomino *bubbly growth traps* o trampas de crecimiento en la presencia de burbujas.

Preface

Our understanding of the financial sector has matured from questioning whether it has any impact on economic growth (see Bhattacharya and Thakor (1993); Boot (2000); Levine (2005); Tirole (2010) for discussions) to a more nuanced understanding of the numerous channels through which it interacts with the real economy. The current consensus is that the efficient allocation of financial wealth engendered by the financial sector is a prerequisite for economic growth and development. If often a benign, welfare improving force that has provided the foundation for the expansion of modern corporations, the sustenance of smaller, privately owned businesses and the improvements in financial access for housing and consumption, the financial sector has also been, if less frequently, an important source of macroeconomic instability and turmoil. As exemplified by the Japanese growth experience in the 1990s or the Great Recession recently, events in the financial sector have the capacity to undo years of economic growth. The three papers in my dissertation aim to expand our knowledge of two specific aspects of the interaction between the financial sector and the real economy - the channels through which shocks to the financial sector (including shocks that arise from regulation) affect the real economy and secondly, the potential for the financial sector to misallocate resources.

In the first chapter, I show a causal link between regulations in Spain introduced in the aftermath of the Spanish real estate bubble and economic activity in Mexican municipalities. The Spanish Government introduced macroprudential regulations in early 2012 that increased the loan-loss provisions to cover any losses arising from the toxic real estate assets in the balance sheet of Spanish banks. These provisions imposed capital requirements in the order of billions of euros on the larger Spanish banking groups. I find that two of these banks, BBVA and Santander, with a significant presence in Mexico reduced lending to Mexican households in response to the Spanish regulations. I defined a natural experiment based on this exogenous shock to the supply of household credit in Mexico and found that Mexican municipalities with a higher exposure to Spanish banks experienced a larger decline in the growth rate of household

credit. The drop in lending to households, in turn, was reflected in a contraction in the amount of credit (a proxy for economic activity) absorbed by the local non-tradable sector in the high exposure municipalities. Hence, the Spanish regulations had the highly unintended consequence of reducing lending to households in Mexico and the resulting drop in aggregate demand was reflected in localized contractions in economic activity in the non-tradable sector. The second chapter, to the best of my knowledge, is the first paper to define a natural experiment based on the international ramifications of a national financial regulation and uses micro data to establish a causal link between macro variables (a la Mian and Sufi (2014); Mondragon (2014)). The result of this chapter is also very policy relevant and emphasizes the need for coordinating macroprudential policies across regulatory agencies.

The second chapter provides empirical evidence and a theoretical explanation for the curious observation that the Spanish regulations did not affect lending to Mexican firms by Spanish banks. I document that the contraction in lending to non-tradable firms in high exposure Mexican municipalities was observed in drops in lending by both Spanish and non-Spanish banks. Secondly, I also show that the contractual terms of marginal credit, in levels and average interest rate, between a firm and Spanish banks do not change relative to those between the same firm and non-Spanish banks. Why would a bank prioritize a lending relationship with a firm over that with a household? I find the answer in a model with asymmetric information (a la Sharpe (1990); Rajan (1992)) in which banks earn positive rents in future financing rounds from projects on which they hold proprietary information. On the other hand, banks earn zero rents on loans that are transactional in nature since such lending, as is the case for lending to households, is based on publicly available information. In the event of a negative shock to bank capital, banks prioritize lending relationships in which they hold proprietary information.

In the third chapter, I study the potential for misallocation of financial resources in an economy with heterogeneous sectors and financial frictions in the presence of asset bubbles. The economy has two sectors - a highly productive, financially constrained sector and an unproductive sector with lower levels of financial constraints. At low levels of wealth, the financial resources of the economy are intermediated to the unproductive sector. With economic growth and consequent lowering of interest rates, a higher fraction of the wealth is allocated to the productive sector and the economy transitions to a phase with high investment productivity and high consumption. Asset bubbles in this model not only crowd-out current investments, but raise interest rates which add to the borrowing constraint faced by the productive sector. The loss of financial resources to asset bubbles can completely rule out the transition to the high

investment productivity phase when the economy never acquires the wealth necessary to make the transition. Such a steady state with low investment productivity is a bubbly *growth trap*. The *growth trap* is marked by low levels of wealth and consumption that are the direct consequence of the low investment productivity. The results described in this chapter are reminiscent of the Spanish growth experience during and in the wake of the housing bubble of 2005-2007, the macroeconomic details of which run through the veins of all three chapters of my dissertation.

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Chapter 1

Effect of Household Credit on Sectoral Composition: Evidence from Mexico

1.1 Introduction

Does the level of household credit affect economic activity in an economy? Recent empirical work (Mian and Sufi (2014); Mondragon (2014)) has shown that more than half the unemployment in the United States during the recent financial crisis can be explained by declines in employment in the non-tradable sector resulting from a contraction in the supply of household credit. These papers emphasize the existence of a local demand effect which causes a positive comovement in activity in the non-tradable sector of an economy in response to changes in lending to local households.[1,2] In my paper, I address the lack of evidence on the afore-mentioned demand effect in emerging economies by showing a causal link between changes in household credit supply and economic activity in the non-tradable sector in Mexico. I resolve the key challenge of identification using a credit supply shock resulting from financial regulations in Spain that led to a slow-down in lending to households by Spanish banks in Mexico. I use this supply shock to study the effect of household credit on investments in different sectors at a municipality level in Mexico.[3]

[1] Household credit is the combination of housing credit (mortgages) and consumer credit. Household credit together with corporate credit is called total private credit.

[2] Other papers that have studied the effect of household credit on local demand or on local economic activity include Agarwal et al. (2007), Glick and Lansing (2009, 2010), Gropp et al. (2014) and Adelino et al. (2015). The last two in particular emphasize the challenges of identifying shocks to local demand via changes in housing net worth or household credit.

[3] I use sector level credit as a proxy for investments in the particular sector in a given period. In June 2012, more than 80% of the credit to firms issued by commercial banks in Mexico was in the

The source of the supply shock was macroprudential regulations undertaken by the Spanish Government to build capital buffers against losses arising from real estate asset holdings, and to alleviate the uncertainty surrounding the quality of assets in the balance sheet of Spanish banks. Introduced in two phases in early 2012 as Royal Decree Law 02/2012 and Royal Decree Law 18/2012, the regulations imposed a retrospective loan-loss provision on real estate assets held as of December 2011.[4] The effects of these regulations were immediate and there was near universal compliance among Spanish banks by June 2012. BBVA and Santander reported additional provisions of 4.4 billion and 6.1 billion euros respectively to meet the new capital requirements. These two large banking groups also reduced lending to households in Mexico in the immediate aftermath of these financial regulations.[5]

Figure 1.1 shows year-on-year growth rates for commercial credit issued by Spanish and non-Spanish banks in Mexico during 2010-2013. There is a clear difference in the growth rate of consumer and housing credit issued by Spanish and non-Spanish banks after June 2012. Remarkably, there is no coincident difference between Spanish and non-Spanish banks in lending to firms.[6] The effect of this slow-down in lending to households was significant since the Spanish banks issued 48% of the mortgage credit and 44% of the consumer credit in Mexico in June 2012. I exploit the variation in this exogenous drop across Mexican municipalities as a natural experiment. I show that municipalities with greater exposure to Spanish banks experienced larger declines in the growth rate of household credit between June 2012 to June 2013. In particular, I use a difference-in-difference specification and find that municipalities with a 10% higher pre-shock share of Spanish banks in the household credit market experienced a 2.5% larger drop in the growth rate of household credit a year after the introduction of the Spanish regulations. This drop is seen for both lending in the form of mortgages

form of working credit. Other papers that use credit as a proxy for investments and economic activity are Khwaja and Mian (2008), Iyer et al. (2013), Amiti and Weinstein (2013), Chodorow-Reich (2014), among others.

[4]Loan-loss provisions, or more literally provisions against loan losses, are capital requirements that provide a buffer against potential losses from a particular loan. The upward revision of the loan-loss provision hence reflects a downward revision of the value of the loan, equivalent to a partial write-down.

[5]The increase in provisions were specifically aimed at Spanish real estate assets in the balance sheet of banks operating in Spain. The drop in lending to households in Mexico is the consequence of the negative liquidity effect resulting from the high provision requirements on a significant part of the banks' loan portfolio. Real estate loans affected by the Spanish regulations RDL 02/2012 and RDL 18/2012 affected more than 10% of the entire loan portfolio for BBVA, coverage for which went up from 18% in 2011 to 43% in 2012 (*Source:* Page 104, Risk Management, BBVA Annual Report 2012). I discuss the international transmission of the liquidity effect of higher provisions on lending to households in Mexico in greater detail in section 1.2.

[6]In section 1.2, I argue that Spanish banks particularly cut the supply of household credit and not firm credit since the former tends to have much longer maturities (mortgages) or higher capital requirements (consumer credit).

and consumer credit.

In order to shed light on the underlying mechanism, I develop a model of a Mexican municipality in which households rely on credit to finance consumption periodically. A shock to the level of household credit affects the local aggregate demand. Since economic activity in the non-tradable sector reflects the level of local demand, the model predicts a positive comovement between shocks to household credit and changes in investment and production in the non-tradable sector.[7] I use the natural experiment described above to study the presence of a local demand effect in Mexican municipalities.

I find strong evidence of the local demand effect in changes in sectoral investments driven by the drop in lending to households by Spanish banks. I show that municipalities with a greater exposure to the shock experienced a higher drop in investments in the non-tradable sector, whereas investments in the tradable sector remained unaffected. In order to ensure that the drop in lending to firms in the non-tradable sector explained by the exposure to Spanish banks does not reflect a direct credit supply shock to those firms, I replicate all the results in a sub-sample of Mexican municipalities with a very limited exposure to Spanish banks for firms in the non-tradable sector.[8] I use the treatment variable, the pre-shock share of Spanish banks, as an instrument to measure the local supply shock to household credit resulting from Spanish regulations. I show that the instrument satisfies the exclusion restriction necessary for identification and does not capture any municipality specific trends in lending to households (or to particular sectors of the economy). Using the exogenous component of the local supply shock to household credit through an IV regression, I estimate an elasticity of investments in the non-tradable sector to changes in household credit ranging from 1.6-3.5.[9] I also detect a drop in the average interest rate of the marginal credit issued to firms in the non-tradable sector in high exposure municipalities, a finding which is consistent with a drop in local demand for goods and services produced by firms in the non-tradable sector in municipalities that experienced a decline in lending to households.

[7] Key theoretical contributions that have studied demand effects of changes in household finance on economic activity are Eggertsson and Krugman (2012), Guerrieri and Lorenzoni (2011)and Midrigan and Philippon (2011). I emphasize the effect on the composition of economic activity through local demand effects in the model in section 1.3.

[8] The sub-sample includes municipalities in which the Spanish banks issued less than 10% of the total credit issued to the non-tradable firms. The identified demand effect does not change for alternate thresholds for selecting municipalities in the sub-sample, which strongly suggests that the treatment variable does not capture a direct credit supply shock to non-tradable firms.

[9] Mian and Sufi (2014) and Mondragon (2014) show a drop in employment in the non-tradable sector in response to negative shocks to household spending. My results show the existence of a complementary channel involving a reduction in investments by the firms specifically catering to local demand in response to a similar shock.

I conduct numerous econometric checks which suggest that the elasticity reported is highly robust. I find that weighted least square results using municipality characteristics such as population, GDP per capita and local financial development as weights are similar to the OLS results. I also present evidence which strongly supports the idea that the identified drop in lending to the non-tradable sector is not biased by the transmission of shocks across the municipalities. The coefficients do not change if I drop small municipalities from the sample, given that these municipalities are more likely to be affected by shocks to demand from neighbouring municipalities. Considering the high concentration of both credit and economic activity in and around Distrito Federal (Mexico City), I show that the coefficients are robust to excluding municipalities in and around Distrito Federal. Finally, I show that drops in investments in the non-tradable sector are largely explained by drops in lending to smaller firms (firms with less than 50 employees), suggesting that the larger firms in the non-tradable sector were more immune to local demand shocks than smaller firms.

To the best of my knowledge, this is the first paper which claims identification based on a plausibly exogenous drop in the supply of household credit in an emerging economy. In assessing the effect of a supply shock to credit on economic activity, my paper is related to macroeconomic literature that studies the effect of financial development on economic growth through a combination of theoretical and empirical analysis. The earliest contributions in this literature established the theoretical basis for the necessity of finance, and empirically assessed the effect of access to finance on economic activity using credit as a proxy for financial development.[10] The key contributions of the theoretical literature and the limitations of the afore-mentioned empirical exercises are well documented in the very exhaustive literature review by Levine (2005). Since then, the recent financial crisis has generated significant interest in research that uses the latest econometric tools to analyze channels through which finance interacts with the real economy.

Broadly, two sub-strands have emerged in response to the recent financial crisis. The first documents the significant rise of household credit (particularly mortgages) in the periods leading upto the crisis, a trend that has not shown any signs of abating after a short-lived slow down during the crisis.[11] The second, centered on the United

[10]The literature preceding the recent financial crisis, by and large, used aggregate credit to the private sector as a proxy for financial development. Empirical results were based on cross-country regressions using dynamic panel techniques (for example Levine et al. (2000), Glaeser et al. (2004) and Aghion et al. (2005)) or on studies that evaluated the effect of financial access on growth at a industrial or firm level (for example Rajan and Zingales (1998), Guiso et al. (2004) and Beck et al. (2005)). The interest in the composition of lending to the private sector between household credit and lending to firms is more recent.

[11]The level of household credit, measured as a percentage of GDP or as a proportion of total

States, questions whether the drop in employment and output during the financial crisis resulted from a drop in household net worth (a demand shock) or was driven by a contraction in lending by illiquid banks (a supply shock). The current paper uses identification techniques similar to key contributions in the second sub-strand of the literature to study the effect of household credit in an emerging economy.

Mian and Sufi (2014) and Mondragon (2014) use exogenous drops in access to household credit at a county level in the US to establish a causal link with drops in employment in the local non-tradable sector. The latter also estimates an elasticity of employment in the non-tradable sector to the level of household credit. While these two papers use domestic shocks to identify the drops in local demand, the current paper differs by using an international financial shock that caused a drop in the supply of household credit at a municipality level in Mexico. This is interesting in two ways. Firstly, an international financial shock that is not related to any domestic crisis helps me address the discussion in Gropp et al. (2014) and Adelino et al. (2015) regarding the alternate channels that can explain the drop in household consumption expenditure during the financial crisis. For example, Adelino et al. (2015) provide evidence which suggests that the fluctuations in lending to households before and during the financial crisis are driven by expectations of future house prices. Based on their interpretation, there is likely to be positive comovement in changes in house prices, lending to households and economic activity in specific sectors driven by changes in expectations, calling into question the causality claims in Mian and Sufi (2014). While these findings are currently under active investigation and review, their criticism does not apply to my paper since the source of the shock in my paper is unanticipated financial regulations in a foreign country. In addition, Mondragon (2014) emphasizes the importance of addressing the possibility of bank selection into specific municipalities/counties. This is a lesser concern in my paper given that I base my exogeneity claims on the distribution of Spanish shares almost a year before the unanticipated Spanish regulations, and I further control for municipality level trends using fixed effects

My paper is also unique in describing an exogenous drop in the supply of household credit driven by the international transmission of a financial shock. The presence of

credit allocated to households, has gone up in almost every country in the last few decades. The results in this paper suggest that greater access to household credit can transform the composition of investments and production between the different sectors of an economy. The change in composition of investment and production towards the non-tradable sector through the demand channel can potentially explain the deeper and longer recessions resulting from a financial crisis ancillary to a boom in lending to households (see Jorda et al. (2015, 2014)). Papers that study the effect of sectoral composition on economic growth are Hausmann et al. (2006), Duarte and Restuccia (2010), Benigno et al. (2015), Perla et al. (2015) etc.

international banks, as in the case of Mexico, exposes a country to shocks that affect the business of the international bank. Peek and Rosengren (1997), Khwaja and Mian (2008), Schnabl (2012), Cetorelli and Goldberg (2011) and Paravisini et al. (2015) are notable examples which use an international transmission channel to study the effect of credit supply shocks on lending to firms. The effect on firms in my paper is indirect - the international financial shock impacts the firms only through the drop in spending by households and does not represent a direct supply shock to firms in any sector per se. Finally, my paper speaks to the international transmission of capital requirements through the presence of large, globalized banks. Houston et al. (2012) have shown that cross-country differences in capital requirements can lead to bank flows towards countries with lower capital requirements. Aiyar et al. (2014) document a scenario closely related to the Spanish regulations discussed in this paper - they show drops in cross-border lending by banks resident in the UK in response to increases in capital requirements in the UK.

The rest of the paper is organized as follows. Section 1.2 discusses the regulations pertaining to loan-loss provisions for real estate assets introduced by the Spanish Government in 2012. Section 1.3 provides a simple 2-sector, infinite horizon model to provide intuition for the mechanism behind the local demand effect. Section 1.4 describes the data and discusses the empirical methodology. Sections 1.5 and 1.6 report the empirical results relating to changes in the composition of credit in response to the supply shock to lending to households. Section 1.7 concludes.

1.2 Spanish regulations & credit supply shock in Mexico

1.2.1 Regulations in Spain - RDL 02/2012 and RDL 18/2012

The newly elected government of Mariano Rajoy in Spain introduced a financial reforms package in early 2012, just 10 weeks after coming to power in December 2011. The reforms were introduced in two rounds - first in February 2012 and then in May 2012 - with the specific aim of restoring investor confidence in Spanish banks by providing greater transparency on the burden of real estate assets and by restructuring the balance sheet to reflect the uncertainty in the value of real estate assets. These twin objectives were attained by imposing increases in mandatory provisions on asset classes related to real estate which, in turn, greatly reduced the operating income of Spanish banks in Mexico. I argue that this drop in operating income was the driving

force behind the drop in the growth rate of household credit issued by Spanish banks starting June 2012.

The first round of reforms, titled the Royal Decree Law 02/2012 and introduced on 3rd February 2012, significantly revised the loan-loss provisions for assets related to real estate. *Specific provisions* were revised upwards for assets which incurred the greatest impairment in their value during the period, namely assets related to land acquisition, foreclosure or projects under development classified as 'Troubled' or 'Doubtful'. On top of this change, a one-off *general* provision of 7% was imposed on the outstanding amount on all standard real estate assets as of December 2011.[12] The second round of reforms, titled the Royal Decree Law 18/2012, pushed upwards the one-off *general* provision requirements of 7% in RDL 02/2012 by 7-45% for different types of mortgage backed real estate assets.

The above measures met with full compliance by the Spanish banks as reported by the Banco de España in their bi-annual Financial Stability Report in 2012. Even though the compliance deadline was set as December 31st 2012, the Financial Stability Report issued in November 2012 mentions that nearly all the banks had reported compliance with the additional provision requirements by June 2012, far ahead of schedule (figure 1.2). While there was an anticipation for financial reforms in Spain during late 2011/early 2012, the exact nature and extent of the financial reforms were not clear until the introduction of Royal Decree Law (RDL) 02/2012 on 3rd February, 2012.[13]

As the two largest Spanish banking groups, BBVA and Santander had the largest burdens resulting from the regulations in early 2012. The sharp upswing in the provisions because of the introduction of RDL 02/2012 and RDL 18/2012 can be understood from a figure taken from BBVA's Annual Report in 2012. Figure 1.3 shows the very second chart from the 'Earnings Report' in the 2012 Annual Report in which the increase in loan-loss provisions are identified as the primary reason behind a drop in net at-

[12]Please see Saurina (2009) for an exhaustive treatment of the specific nature of provision requirements in Spain. *Specific provisions* are the asset specific capital requirements based on the average loan losses resulting from holding that specific asset. *General provisions* are imposed on a per-period basis by the central bank, Banco de España, as a counter-cyclical macroprudential tool. The reforms in 2012, RD 02/2012 and RD 18/2012, were a combination of an increase in *Specific Provisions* to reflect an impairment in the value of real estate assets in an on-going basis and a one-time *general provision* reflecting the deterioration in the quality of existing real estate assets in the balance sheet of Spanish banks. These two measures collectively were aimed at inspiring greater confidence in the Spanish banking system.

[13]The election manifesto of PP, the winners of the December 2011 elections, mentions the likelihood of financial reforms to confirm banking regulations in Spain with international best standards and with regulations elsewhere in Europe. While neither the election outcome, nor the likelihood of financial reforms were unexpected, there was no clarity as to the nature and extent of the financial reforms. The retrospective loan-loss provisions can be argued as unanticipated.

tributable profits of almost 1.5 billion euros despite an increase in operating income for the year 2012 against the levels in 2011. The message is clear - the drop in profitability vs earlier years is owing to the hit of 4.4 billion euros to earnings from the loan-loss provisions imposed on Spanish real estate assets. The comparable figure for Santander was an outlay of 6.1 billion euros as loan-loss provisions and a corresponding hit to net profits. In addition, in its Annual Report for 2012, Santander reports increasing the provision requirements for real estate loans in Brazil and Chile in response to the regulatory changes in Spain.

1.2.2 Effect of Spanish regulations on Spanish banks in Mexico

BBVA and Santander, the two largest Spanish banks by market capitalization and asset holdings world-wide, have a significant presence in Mexico. As we shall see, the drop in net operating income for both the banks in 2012 was not without consequence for their operations in Mexico. I first describe the presence of Spanish banks in Mexico before analyzing how the regulations in Spain acted as a financial shock to lending in Mexico, particularly to the supply of household credit.

BBVA Bancomer, a wholly owned subsidiary of the BBVA Group head-quartered in Spain, is the largest banking group in Mexico. BBVA Bancomer is the also the leading lender of commercial credit of all types - housing credit, consumer credit and corporate credit - in Mexico.[14] In June 2012, it accounted for 28% of all commercial credit issued by banks in Mexico, with a strong dominance in the mortgage and consumer credit markets where it issued 37% and 44% of the total credit at a national level.[15] Together with Santander, these two Spanish banks issued almost 40% of the total commercial credit in Mexico in 2012, with their presence strongly felt in the household credit (combining housing credit and consumer credit) market where there share stood at 48%.

The sharp divergence in the growth rate of housing credit and consumer credit between Spanish and non-Spanish banks in June 2012 is a result of the provision requirements instituted in February and May 2012. The increase in loan-loss provisions led to

[14] Consumer credit aggregates credit issued as credit cards, payroll credit, personal loans, car loans or durable goods' loans. Corporate credit is the credit issued to entrepreneur's and firms. Commercial credit, distinct from corporate credit, refers to the entire portfolio of credit issued by banks. Almost 98% of housing credit is issued as mortgages - hence housing credit is used interchangeably as mortgage credit.

[15] Not only do Spanish banks have a significant presence in Mexico, Mexico has a weighty presence in the gross income statement of these banks. 25% and 13% profits of BBVA and Santander respectively are attributed to Mexico in 2012.

an immediate and sharp decrease in the net attributable income. Banco de España reported an almost immediate compliance to the new requirements by June 2012, indicating an immediate effect on lending by Spanish banks as well. The Mexican subsidiaries of the Spanish banks are only partially financed by customer deposits (the figure for 2012 was 44% and 53% for BBVA and Santander respectively), a feature that makes them susceptible to funding availability at the headquarters in Spain. Three channels are proposed to explain the drop in lending by the Spanish banks in the aftermath of the increase in capital requirements. First, the increase in loan-loss provisions could have acted as a signal of the true value of the bank and acted as a negative liquidity shock for the banks in the wholesale credit market. Second, loan-loss provisions could have negatively affected the amount of leverage in the balance sheet of the banks and, since equity financing is expensive at times of crises, banks would have no option but to retract parts of their lending portfolio. Third, it is also possible that that new provision rules, though applicable to holdings of Spanish real estate assets, also affected the provisions held by Spanish banks for housing credit loans in Mexico, as was done by Santander in Brazil and Chile. I remain agnostic as to the strength of these three channels.

As I show in section 1.4, municipalities with a higher pre-shock share of Spanish banks in household credit experienced a greater drop in the growth of household credit. This difference provides a setting to study the effect of an exogenous drop in the supply of household credit on the macroeconomy of a municipality. Before sharing the empirical results, I discuss a macroeconomic model of a Mexican municipality to develop intuition for the results that follow.

1.3 Model of a Mexican Municipality

The unit of observation in the natural experiment I described in section 1.2 is a Mexican municipality. I model Mexican municipalities as small, open economies with immobile labour and free movement of capital between the municipalities. Firms operate in one of two sectors in the economy - a tradable sector producing a good traded across the municipalities and a non-tradable sector producing a good specifically meant for local demand. Households in the economy are financially constrained and rely on access to household credit periodically to finance consumption. The level of household credit depends on an exogenously determined, municipality-specific parameter. The natural experiment described in the earlier section is modeled a shock to this particular parameter, leading to a variation in the changes to household credit across the municipalities. I use the model to share intuition on the demand channel - i.e., the effect of

a shock to household credit on the composition of investment and production between the tradable and non-tradable sector in an economy through its effect on aggregate demand in an economy.

1.3.1 Model description

The representative Mexican municipality, identified by subscript 'j', is a small open-economy with two sectors and infinitely lived heterogeneous agents. The unit of decision making is a household and the terms agents and households are used interchangeably in what follows. The economy comprises of two types of households - capital owners who own the firms in the economy and workers who are endowed with labour and are engaged by the firms owned by the capital owners. The capital owners own firms in one of the two possible sectors - a sector producing a tradable good and othe other a non-tradable good. The tradable good can be traded across the municipalities for a given interest rate. The non-tradable good can not be traded between the municipalities. Hence the production for a non-tradable good must be met by the demand for the same within a municipality, and vice-versa.

I begin the presentation of the model with the consumption-saving decision of the capital owners, the optimal consumption path available to the workers and the resulting equilibrium in the infinite horizon problem of this economy. The decisions are made in the absence of any aggregate uncertainty though the economy may experience shocks periodically. I study the effect of shocks to ϕ_j on economic activity in the municipality.

1.3.2 Household problem

There are two types of households in the economy - capital owners and workers. Capital owners are not endowed with any labour and their per-period consumption and saving decisions are aimed at maximizing their life-time utility given by

$$U_0 = max \sum_{t=o}^{\infty} \beta^t log\{c_t\} \tag{1.1}$$

$$\text{for } c_t = (c_{Tt})^{\tau}(c_{Nt})^{1-\tau},$$

$$R_t a_t = c_t + a_{t+1}, \text{ given } a_o$$

The consumption in any given period, c_t, is a Cobb-Douglas aggregate of the tradable and non-tradable good. For a given starting value of asset holdings a_0 and inter-

est rate R_t, the solution to the dynamic programming problem provides the optimal consumption , c_t^i, and saving, a_{t+1}^i function for the capital owners in this economy as

$$c_t = R_t(1-\beta)(\prod_{s=0}^{t-1} R_s\beta)a_o \text{ and } a_{t+1} = (\prod_{s=0}^{t} R_s\beta)a_o \tag{1.2}$$

The average interest rate R_t, for period 't', is an equilibrium outcome based on the optimal portfolio choice by the capital owners for their savings. The savings of the capital owners can either be invested domestically in the tradable or non-tradable industries or lent abroad for interest rate R^*. Since investments are made by risk-neutral agents under perfect foresight, capital owners invest in the two sectors until the marginal return to capital in either sector, $\{R_{Nt}, R_{Tt}\}$, equals the lending rate R^*, i.e. $R_t = R_{Tt} = R_{Nt} = R^*$.

The workers optimize their lifetime utility given by an infinite sum of a non-separable utility function per period that reflects utility from consumption and disutility from working. I use a specific form of Greenwood-Hercowitz-Hofman preferences as follows

$$U_0 = max \sum_{t=o}^{\infty} \beta log\{c_t - \eta\frac{(n_t)^{1+\psi}}{1+\psi}\} \tag{1.3}$$

$$\text{where } c_t = (c_{Tt})^{\tau}(c_{Nt})^{1-\tau} \ ,$$

$$R^*a_t + w_t n_t = c_t + a_{t+1} \text{ and } -a_{t+1} \leq \phi_t \frac{w_{t+1}n_{t+1}}{R^*}$$

While the workers must consume every period, their labour endowment is staggered over their lifetime. I assume that workers supply labour in alternate periods of their existence and belong to one of two categories, H_E and H_O, based on whether they supply labour during even-numbered or odd-numbered periods. I also assume that the workers are constrained and can borrow upto a fixed proportion of their next period income. This proportion, ϕ_j, is specific to municipalities and governs the maximum amount of household credit accessible by households in the municipality at time 't'.

I further assume that the workers are impatient (β is less than a threshold value $\bar{\beta}$) and financially constrained (borrowing constrained $\phi_j < \frac{1}{1+\beta} \cdot \frac{\psi}{1+\psi}$). Under these twin assumptions, workers in the economy behave as hand-to-mouth consumers. When not endowed with labour, the households borrow at the limit to finance their consumption. I call these households the 'Constrained Workers'. The remaining workers, whom I call the 'Employed Workers' clear their outstanding debts and consume what is left of their wages. Hence for a even time period 't', the consumption profile is given by,

$$c_t^i = \begin{cases} (1-\phi)\cdot w_t n_t & \text{if i} \in H_{even} \\ \phi \cdot \frac{w_{t+1}n_{t+1}}{R^*} & \text{if i} \in H_{odd} \end{cases}$$

where n_t is the labour supply given by the market wage $\{\frac{w_t}{\eta}\}^{\frac{1}{\psi}}$. In odd periods, the workers from the two different sets interchange their roles as constrained workers and employed workers. Thus, the total spending from the two types of workers in any period 't' is given by $(1-\phi_{t-1})\cdot w_t n_t + \phi_t \frac{w_{t+1}n_{t+1}}{R^*}$.

1.3.3 Production

Firms are perfectly competitive Cobb-Douglas aggregators of capital and labour which specialize in the production of a sector specific good. There is full depreciation of capital every period and the level of capital in a given sector is determined by the level of sector specific investments in the previous period. The production function for firms in the tradable sector is given by $F_T(K_{Tt}, L_{Tt}) = Z_{Tt}K_{Tt}^{\alpha_T}L_{Tt}^{1-\alpha_T}$ and for firms in the non-tradable sector by $F(K_{Nt}, L_{Nt}) = Z_{Nt}K_{Nt}^{\alpha_N}L_{Nt}^{1-\alpha_N}$, where $\{Z_{Tt}, Z_{Nt}\}$ are the sector-specific productivities, $\{\alpha_T, \alpha_N\}$ the levels of capital intensities, $\{K_{Tt}, K_{Nt}\}$ the levels of capital and $\{L_{Tt}, L_{Nt}\}$ the labour allocated in time 't'.[16] The tradable good is the numeraire and the relative price of the non-tradable is given by P_{Nt}.

The market clearing condition in the labour market entails that the demand for labour $\{L_{Nt} + L_{Tt}\}$ must equal the supply of labour. For wage rate w_t, the total supply of labour is given by $(\frac{w_t}{\eta})^{\frac{1}{\psi}}$. Hence the labour market clearing condition is given by,

$$L_{Nt} + L_{Tt} = (\frac{w_t}{\eta})^{\frac{1}{\psi}} \tag{1.4}$$

Risk neutral capital owners invest in the two sectors until the marginal return to capital in each sector equals R^* as summarized in the equation below,

$$R^* = \alpha_T \cdot Z_{Tt} \cdot (\frac{K_{Tt}}{L_{Tt}})^{\alpha_T - 1} = \alpha_N \cdot P_{Nt} \cdot Z_{Nt} \cdot (\frac{K_{Nt}}{L_{Nt}})^{\alpha_N - 1} \tag{1.5}$$

Finally, the relative price of the non-tradable good is determined by the market clearing condition in equation 1.6, the *demand equation,* which equates the total spending on non-tradables by households in period t to the total value of production in the non-

[16] The sector specific factor intensiveness and productivities can vary across the municipalities. In general, I assume that the preferences are the same for households across the Mexican municipalities and the differences across the municipalities stem from the parameter ϕ_j and sector specific production functions. Except for ϕ_j, I drop the municipality specific subscript 'j' to minimize notation since we restrict the discussion to a representative Mexican municipality in this section.

tradable sector as follows[17],

$$(1-\tau)\cdot\{\underbrace{R^*\cdot a_t\cdot(1-\beta)}_{Capital\ Owners}+\underbrace{(1-\phi_{t-1})\cdot w_t n_t}_{Employed\ Workers}+\underbrace{\phi_t\cdot\frac{w_{t+1}n_{t+1}}{R^*}}_{Constrained\ Workers}\}=P_{Nt}\cdot Z_{Nt}\cdot K_{Nt}^{\alpha_N}\cdot L_{Nt}^{1-\alpha_N} \tag{1.6}$$

At time 't', for given values of $\{K_{Nt}, K_{Tt}\}$, the market clearing conditions discussed in this section establish the equilibrium outcomes$\{L_{Tt}, L_{Nt}, R_{Tt}, R_{Nt}, P_{Nt}, w_t, K_{Nt+1}K_{Tt+1}\}$. In the next section I study how changes in the level of household spending driven by changes in $\phi_{j,t}$ affect economic activity in the two sectors.

1.3.4 Equilibrium

The workers in the economy rely on access to household credit for consumption during periods when they do not earn wages since their income is concentrated in alternate time periods. Changes in access to household credit, through shocks to parameter ϕ_j, are reflected in both the household credit accessed and the household debt repaid every period. I present the effect of a temporary and permanent shock to household on economic activity in the two sectors of the economy in *result 1* and *result 2* respectively.

Result 1: A temporary shock that leads to a drop in the level of household credit *always* leads to a drop in investment and production in the non-tradable sector of the economy.

Result 2: A permanent drop in the household constraint parameter ϕ_j leads to a permanent decrease in the level of investments and production in the non-tradable sector if and only if $R^* < (1+g)^{\frac{1}{1-\alpha_T}}$ where g is the growth rate of the productivity in the tradable sector.

I refer to the demand equation (eq. 1.6) to provide an intuitive interpretation of these two results. A temporary contraction in the level of household credit leads to a drop in the spending on goods and services contemporaneously. This is because the shock leads to drop in the contemporaneous borrowing by the constrained workers, without affecting the outstanding household debt of the employed workers (*result 1*). A

[17] Equation 1.6 is valid for the case when there is no shock experienced at period 't'. In the event of a shock the net wealth of the capital owners would be given by $\underbrace{R_{Nt}\cdot K_{Nt}+R_{Tt}\cdot K_{Tt}-R^*\cdot(K_{Nt}+K_{Tt}-a_t\cdot(1-\overline{\beta}))}$ since the eventual investment risk in the model is absorbed by capital owners and shocks may shift the return to investments away from R^*. The wealth of the households that supply labour during the period will be given by $\underbrace{w_t n_{t,}-\phi^h_{t-1}\cdot E_t(w_t n_t)}_{Employed\ Workers}$ instead of $\underbrace{(1-\phi_{t-1})\cdot w_t n_t}_{Constrained\ Workers}$.

permanent change in the level of household credit ϕ_j affects both the contemporaneous household credit borrowing and the outstanding household debt in future periods. A permanent drop in household credit would lead to a drop in the total spending as long as the negative effect on current borrowing outweighs the rise in spending in the future after clearing the lower debt acquired in the previous period. If wages are constant (no productivity growth in the tradable sector), that can happen if and only if $R^* < 1$ and in case of productivity growth, if and only if, $R^* < (1+g)^{\frac{1}{1-\alpha_T}}$.

In figure 1.5, I shock an economy at steady state with a temporary one-period drop in the level of household credit. As set down in *result 1,* the effect of a temporary drop in the level of household credit is independent of parameters governing the economy and always leads to a contemporaneous drop in economic activity in the non-tradable sector. In case of a permanent drop in the level of household credit, in the short term the economy sees a drop in the level of economic activity in the non-tradable sector and the eventual transition to a new steady state marked by an expansion or contraction in the non-tradable sector depending on the condition laid down in *result 2.* In figure 1.6 I show the transition in the event of a permanent shock to the level of household credit for an economy with $R^* < 1$.

Figure 1.7 shows the transition in an economy with a temporary, though persistent, shock to the level of household credit. The economy experiences a negative shock at time period $t = 10$ and experiences a drop in the level of household credit from $\phi_{H,j}$ to $\phi_{L,j}$. From $t = 12$, the level of household credit recovers based on the process $\phi_{j,t} = \phi_{j,t-1} + \theta \cdot (\phi_{H,j} - \phi_{j,t-1})$. The economy experiences an expansion in the non-tradable sector along the transition process since the gain in spending from better access to household credit outweighs the negative effect of the higher amount that must also be repaid very period. Figure 1.8 highlights the exact opposite transition process in an economy with $R^* > 1$). In this economy, there is an increase in overall spending in response to a drop in access to household credit since the debt burden every period outweighs the additional demand from better access to credit.

1.4 Data Description and Empirical Methodology

1.4.1 Data description

I use publicly available data from CNBV for household credit and credit-registry data on firm credit to build a panel of credit issued by commercial banks at a municipality level in Mexico from June 2011 to June 2013 at a half-yearly level. Household credit is

disaggregated into mortgages and consumer credit.[18] Consumer credit is an aggregate of credit issued as credit cards, personal loans, car loans, payroll credit and durable goods' loans. The reason for limiting the database to the period 2011-13 is that data on the actual amount of credit issued as credit cards, almost 13% of total commercial credit in our sample, is available only starting February 2011. CNBV only reports the number of credit cards at a municipality level in periods prior to 2011. Even so, the available data allows me to observe changes in lending to households and industries at a municipality level after the introduction of Spanish regulations.

Data on firm credit is obtained from the 'R-04C' credit registries which include details on all the credit lines between banks and firms, reported at a monthly level. In addition to the outstanding credit, banks report the interest rate, date of origination, maturity, and quality of collateral of the loan. Banks also report firm-level characteristics including the number of employees, the firm's revenue and the firm's reported industry. A firm's industry is represented by a 5-digit code that can be matched to the 2007 NAICS industrial classification at a 5 digit level.[19] I aggregate the credit reported in the credit registry at a 4-digit NAICS industry-bank-municipality level. I also exploit the interest rate dimension of the credit registry to include average interest rates of credit issued to 4-digit NAICS industries at a municipality level.

The 279 4-digit NAICS industries are classified into the non-tradable and tradable sectors based on the criterion used in Mian and Sufi (2014). All industries that are a part of the retail and restaurant sector are classified as the non-tradable sector and industries with gross imports+exports greater than USD $ 500,000 or USD 10,000/employee in the US are classified as tradables. The tradable industries are identified using disaggregated trade data for Mexico for the year 2010 downloaded from the International Trade Statistics Database maintained by Comtrade, UN. The gross trade/employee data is obtained by combining the industry level trade data with the by industry employment data in Census 2009.[20] 23 industries are classified as belonging to the 'construction' sector and the remaining industries are classified as 'Others'.

[18] *Comisión Nacional Bancaria y de Valores,* http://www.cnbv.gob.mx/Paginas/default.aspx

[19] 'R04C' 5-digit codes perfectly match NAICS-2007 Industrial Classification for most industries except the NAICS-2007 industries starting with 44 and 45 (43 and 46 in 'R04C'), the 'Retail' and 'Wholesale' sectors respectively. A reconciliation between the unmatched 'RO4C' industry and their counterpart in NAICS-2007 is provided in the online Appendix.

[20] While I use the same thresholds used by Mian and Sufi (2014) to classify industries as tradable, I find a close match between industries identified as tradable by them using American trade data and by me using Mexican trade data. The discrepancies are presented in the appendix.

1.4.2 Summary statistics

The credit database described above includes outstanding credit to households (as mortgages or consumer credit) and firms (by sector) for 999 municipalities in Mexico.[21] Figure 1.4 (a) shows the distribution of these municipalities on a map of Mexico, where as table 4 shares summary statistic for key variables. The municipalities covered have an average size of 1193 sq. km. and are drawn from all the 32 Mexican states. The low level of financialization in Mexico is also apparent in access to credit at a municipality level. The average Mexican municipality in the sample has a $Credit/GDP$ ratio of just 19.9%. The credit series at a municipality seem to expand year on year. I report this increase using changes in log-levels of credit series between June 2011 and June 2012. I also observe that the changes in log-level of credit to firms shows a greater variability than the changes in credit to households. I show the variation in the presence of Spanish banks using the share of Spanish banks in the markets for different credit types. I use the bank-municipality dimension of my database to compute the share of Spanish banks in the specified credit market for June 2011. The share of Spanish banks in the household credit market is normally distributed across the municipalities, as can be seen in figure 1.9.

I further refine the natural experiment by considering a sub-sample of municipalities with very low shares of Spanish banks in the non-tradable credit market. In particular, I use a sub-sample of 379 municipalities in which the share of Spanish banks in the non-tradable credit market is less than 10%. Any effect on lending to the non-tradable sector identified in this sub-sample can be interpreted with much less concern for capturing a direct supply shock to non-tradable firms resulting from the Spanish regulations. As I shall show shortly, the results of the natural experiment as defined in the full sample closely match the results from this sub-sample. These 379 municipalities are also drawn from all the 32 states, are uniformly distributed across the different regions of Mexico (figure 1.4 (b)) and most importantly, have a distribution of Spanish share in household credit market that matches the distribution in the full sample (table 1.10).

1.4.3 Empirical methodology

The main challenge in estimating the effect of changes in household credit on economic activity is that changes in household credit are highly endogenous. Since I use changes

[21] Mexico has 2456 municipalities. The municipalities included in the sample are the ones which have complete data on all credit types for the entire duration covered by the database. The 999 municipalities comprising the sample account for % and % of the total credit and total economic activity at a national level. The sub-sample of 379 municipalities accounts for % and % of the total credit and total economic activity at a national level.

in credit to different sectors as an outcome variable, it is easy to see why a regression of changes in lending or employment or production in a given sector on changes in lending to households does not identify the demand channel. For example, in the model in the previous section, a productivity shock can affect the level of investment in a given sector through its effect on factor costs and the level of household credit through its effect on real wages. Hence any estimate of ψ_s that is not based on a truly exogenous change in lending to households will be biased. I use a difference-in-difference specification to measure the exogenous drop in the growth rate of household credit at a municipality level in Mexico resulting from the Spanish regulations. In the natural experiment depicted diagrammatically in figure 1.11, I regress changes in lending to households in periods before and after the introduction of Spanish regulations (June 2012) on a constructed treatment variable $Post \cdot Spanish\ Share_{j,2011}$, where $Post$ refers to periods after June 2012 and $Spanish\ Share_{j,2011}$ is the share of Spanish banks in household credit in municipality 'j' in June 2011. I control for municipality and time fixed effects in the difference-in-difference regressions to allow for different trends in the household credit series between the municipalities. The regression equation is given by

$$\Delta \log(h_{jt}) = \beta \cdot Post \cdot Spanish\ Share_{j,2011} + D_j + D_t + \varepsilon_{jt},$$

where h_{jt} refers to household credit for municipality 'j' at time 't', D_j are municipality dummies and D_t are time dummies. The coefficient β on the interaction term explains the changes in the growth rate of household credit explained by the share of Spanish banks after the introduction of Spanish regulations. To the extent that the treatment variable provides us with precise measurements of the supply shock to household credit at a municipality level, I can use it as an instrument for the municipality level drops in lending to households. The difference-in-difference regression of the changes in lending to households on the treatment variable is the first stage. In the second stage I use the drop in lending to households measured by the first stage to estimate the effect ψ_s of household credit on lending to sector of the economy,

$$\Delta \log(c_{sjt}) = \psi_s \cdot \Delta \log(h_{jt}) + D_j + D_t + \eta_{sjt},$$

where c_{sjt} is the credit lent to sector 's' in municipality 'j' at time 't'.

The exclusion restriction in the instrumented variable set-up requires that the instrument be uncorrelated with the error terms in the second stage, i.e $E(Post \cdot Spanish_{j,2011} * \eta_{jt}) = 0$. I test for this condition by showing that any effect on the lending to specific sectors of the economy that is explained by the instrument is not the result of a direct effect or through omitted variables, for e.g., as would be the

case if the Spanish shares were to capture a direct supply shock to firms in a particular sector in a given municipality. I do this in three ways. Firstly, I test for the presence of the demand channel in a sub-sample of municipalities where non-tradable firms have a very limited exposure to Spanish banks. Secondly I show changes in average interest rates of the marginal credit issued to firms in the non-tradable sector that are inconsistent with the contraction in lending those firms being the result of a direct credit supply shock to from Spanish banks. Finally, I conduct placebo tests as a validation of the instrument strategy based on difference-in-difference estimation.

1.5 Empirical Results

1.5.1 Supply shock

I use the share of Spanish banks to measure the supply shock to household credit resulting from the Spanish regulations. I use a difference-in-difference specification to show that municipalities with a higher exposure to Spanish banks saw a greater decline in the growth rate of household credit. To measure the slow-down in lending to households, I use annual data on lending to households from June 2011 to June 2013, a year prior to and after the Spanish regulations came into effect. I treat June 2012 as the instance when the natural experiment was implemented across Mexican municipalities, a month after the second round of macroprudential regulations were imposed by the Spanish Government. I define an interaction term $Post \cdot Spanish\ Share_{j,2011}$ as the treatment variable in the natural experiment to measure the supply shock at a municipality level. *Post* is a dummy variable for the periods after the introduction of the shock, June 2013 in this particular case. $SpanishShare_{j,2011}$ is the share of Spanish banks in the household credit market for municipality 'j' in June 2011, an year before the introduction of the Spanish regulations. The regression specification is given by

$$\Delta \log(h_{jt}) = \beta \cdot Post \cdot Spanish\ Share_{j,2011} + D_j + D_t + \varepsilon_{jt}, \tag{1.7}$$

where we regress the annual changes in log-levels of household credit for municipality 'j' from June 2011-June 2013 on the treatment variable in the presence of municipality (D_j) and time (D_t) fixed effects. The municipality fixed effects control for any changes in the log-level of household credit that result from municipality specific trends in lending to households. If there is any selection by Spanish banks into municipalities with higher or lower trend growth rates in household credit, municipality fixed effect allow me to estimate shocks to the growth rate of household credit controlling for

municipality specific trends. I report standard errors clustered at a municipality level (with 999 or 379 clusters depending on the sample) to allow for serial correlation in the credit series. This is very conservative since I already take first differences of the credit series to measure the effect of Spanish regulations on the growth of household credit lending across Mexican municipalities.

I report a highly negative and significant estimate of β in tables 1.6 (a) and (b). Results show that a 10% higher exposure to Spanish banks predicts a drop of 2.5% in the growth rate of household credit an year after the introduction of the Spanish regulations. Further, I show that the slow-down in lending to households comes from drops in the growth rates of both consumer credit and housing credit (columns (2) and (3) of table 1.6 (a) and table 1.6 (b)). These results hold for the full sample of 999 municipalities and the sub-sample of 379 municipalities. Thus, the variation in the share of Spanish banks in household credit leads to a variation in 'treatment' to the supply shock resulting from the Spanish regulations. I show a drop in lending to firms in the non-tradable sector in high Spanish share municipalities explained by the treatment variable using the difference-in-difference specification described in this section (table1.7).

1.5.2 IV results

I provide estimates of the elasticity of changes in investments in the non-tradable sector to changes in the level of household credit using an estimate of the exogenous supply shock to the growth of household credit at a municipality level. In general, the coefficient of regressing changes in the log-levels of investments in a particular sector on changes in log-levels of household credit is not identified since the credit to households and credit to firms are equilibrium outcomes based on market clearing. As discussed in section 1.3, the level of household credit depends on an exogenously determined parameter ϕ_j and the wages w_{jt} earned by households in the municipality during the period. The wages are equilibrium outcomes that are also affected by shocks that determine the level of credit in different sectors. Hence regressing changes in the level of credit to a particular sector on changes in household credit is not identified.

Instead, I measure the exogenous change in household credit supply at a municipality level which is uncorrelated with other municipality specific shocks that affect contemporaneous credit levels to different sectors. I use the pre-shock share of Spanish banks in household credit to instrument the drop in household credit in periods after the introduction of the Spanish regulations to measure the supply shock at a municipality shock. The measured supply shock then gives us the elasticity of investments in the non-tradable sector to changes in the level of household credit.

The specification described above can be represented as,

$$\Delta \log(c_{sjt}) = \psi_s + \Delta \log(h_{jt}) + D_j + D_t + \eta_{sjt}, \tag{1.8}$$

where the supply shock is measured by instrumenting for changes in the log-level of household credit as per the first stage described in equation 1.7. The exclusion restriction requires that the variation in the changes in log-levels of credit to any specific sector not be directly explained by the instrument $Post \cdot Spanish\ Share_{j,2011}$. For example, the exclusion restriction would be violated if there existed a direct supply shock to firms that were to be picked up by the treatment variable. I use the sub-sample with a limited exposure for non-tradable firms to Spanish banks to show that the contraction in economic activity in the non-tradable sector in treated municipalities is not the result of a direct supply shock from Spanish banks.

I report the elasticity of investment in the non-tradable sector to changes in lending to households in tables 1.8 and 1.9 which are based on the full sample of 999 municipalities and the restricted sub-sample of 379 municipalities respectively. I regress annual changes in log-levels of credit issued to the non-tradable sector, the tradable sector and a series that groups the non-tradable and construction sector on changes in log-levels of household credit instrumented by $Post \cdot Spanish\ Share_{j,2011}$. The first stage results yield a F-stat value of 52 for the full sample and 14.5 for the restricted sub-sample. The estimated elasticity ranges from 1.65 for the full sample to 3.49 for the restricted sub-sample of municipalities. The elasticity obtained from the restricted sub-sample is larger than the one estimated from the full sample, indicating that it is unlikely that there is a direct supply shock component in the drop in lending to non-tradable firms in high Spanish exposure municipalities.

In the next sub-section, I share direct evidence of the demand channel at work at a municipality level in Mexico using average interest rates of the marginal credit issued to firms in non-tradable sector in periods before and after the introduction of financial regulations..

1.5.3 Interest rates and the demand channel

I use data on the contract terms of each credit line to create a database of the average interest rate for marginal credit issued to different sectors at a municipality level at a half-yearly frequent from June 2011 to December 2013. I show that there is a drop in the average interest rate of the marginal credit issued to non-tradable firms in

high Spanish exposure municipalities (table 1.10) after the introduction of Spanish regulations. To do so, I compare the average interest rate of the marginal credit issued to a particular sector in the final quarter of 2012 (6 months after the shock) against the level in the 2nd quarter of 2011 (a year before the shock). I use the difference-in-difference specification described in the earlier sub-sections to test whether there was a change in the interest rate of the marginal credit issued to specific sectors that is explained by the treatment variable, $Post \cdot Spanish\ Share_{j,2011}$. The regression equation is given by,

$$IntRate_{sjt} = \gamma_s \cdot Post \cdot Spanish\ Share_{j,2011} + D_j + D_t + \nu_{sjt},$$

where $IntRate_{sjt}$ is the average interest rate of the marginal credit issued to sector 's' in municipality 'j' at time 't'. D_j and D_t are municipality and time dummies respectively and $Post \cdot Spanish\ Share_{j,2011}$ is the treatment variable. Results in table 1.10 show a decline in the average interest rate of the marginal credit issued to the non-tradable sector in high exposure municipalities. I observe this drop in the interest rate of the marginal credit issued in the last quarter of December 2012 for the full sample and the sub-sample of municipalities. The sub-sample municipalities see a greater decline in the average interest rate of the marginal credit issued to the non-tradable sector, which is consistent with finding a stronger decline in the growth of credit to the non-tradable sector in the sub-sample. Finding an effect in the sub-sample is crucial for this test since it is possible that the drop in the interest rate of the marginal credit issued to non-tradable firms is also the consequence of a supply shock where the Spanish banks cut credit to riskier firms with higher interest rates. Validating results from a sub-sample where credit to the non-tradable firms is largely issued by non-Spanish banks suggests that the effect captured by the treatment variable is unlikely to be the result of a direct supply shock from Spanish banks.

This drop in the interest rate of the marginal credit to the non-tradable sector is consistent with the slow-down in lending to firms in the sector driven by a drop in demand for their goods and services in municipalities with high exposure to Spanish banks. If the drop in lending to the non-tradable sector was the result of a supply shock, results would have shown an increase in the average interest rate of the marginal credit issued to the non-tradable sector.

1.6 Robustness checks

1.6.1 Placebo tests

I argued in section 1.5 that using fixed effects in the difference-in-difference specification and the parallel trends (in figure 1.12) suggest the lack of differential trends in household credit issued in high and low exposure municipalities. I provide additional evidence on the lack of differential trends using placebo tests to show that the treatment variable ($Post \cdot Spanish\ Share_{j,2011}$) does not predict any changes in the growth rate of lending to households or firms in periods before June 2012. I define a hypothetical experiment in June 2011 in which I check whether the treatment variable $Post-Placebo \cdot Spanish\ Share_{j,2011}$ predicts any differences in the growth of credit to households and firms in the non-tradable sector during December 2010 to December 2011. The variable $Post - Placebo$ identifies periods after June 2011, the treatment period of our hypothetical experiment. I show the natural experiment and the placebo test next to each other using a diagram in figure 1.11. If there indeed were municipality specific trends that were captured by the share of Spanish banks in household credit in 2011, the treatment variable would capture those trends and predict either an increase or decrease in the growth rate of the credit in periods after June 2011.

I show the placebo test results in table 1.11 for mortgage credit and credit to firms in the non-tradable sector. I find that the share of Spanish banks in household credit does not predict any differential growth trend in the treated sample in the post-trial period of the placebo experiment. Therefore, the slow-down in lending to households and firms in the non-tradable sector after June 2012 that is predicted by the Spanish shares is not the result of municipality specific trends, but an outcome of treatment in the natural experiment.

1.6.2 Weighted least squares

In table 1.13 I report weighted least square coefficients of the effect of the treatment variable, $Post \cdot Spanish\ Share_{j,2011}$ on the changes in the credit to the non-tradable sector at a municipality level. The coefficient is very stable in the regressions based on the sub-sample for weighting across different municipality characteristics. I implement weighting based on the GDP per capita and the GDP reported in 2010 (both from the Census in 2009) and the number of branches per 10,000 people at a municipality level (from INEGI). The WLS coefficients for the regressions based on the full sample are also fairly stable. Only in the case of weighting the municipality observations by

municipality population (from INEGI) do I find a sharp jump in drops in lending to the non-tradable sector attributed to exposure to Spanish banks.

1.6.3 Transmission of shocks across municipalities

I report robustness checks against any potential bias due to the transmission of local shocks across the borders of a municipality. The average size of a Mexican municipality in the full sample of 999 municipalities is 1193 sq. km., with the municipality at the 10th percentile spread across 65 sq. km. There is a potential for the transmission of a shock to household credit in a given municipality on economic activity in bordering municipalities driven by demand spillovers which can bias the estimates of the elasticities reported in the earlier section. Such demand spillovers are likely to be stronger for smaller municipalities, particularly if there is a bunching of small municipalities. I show in table 1.14 that the treatment effect on lending to the non-tradable sector is robust to the exclusion of small municipalities. In Column (5) I show that the results hold for municipalities that are larger than 200 sq. km. in the full sample and the sub-sample of municipalities. Moreover, the coefficient is stable to the threshold we pick to drop observations from smaller municipalities.

In columns (3) and (4) of table 1.14, I report the treatment effect by excluding the municipalities in Distrito Federal (DF) and the municipalities in DF and surrounding states of Estado de Mexico and Morales respectively.[22] Dropping these central municipalities does not affect my results. As an additional check, I report results by aggregating data at a metropolitan level. Mexico has 59 metropolitan areas. In results I present in the appendix, I find that the loss in power by aggregating data by metropolitan area does not allow me to identify an effect of the exposure to Spanish banks on lending to households or firms in the non-tradable sector.

1.6.4 Firm size

In table 1.15, I report regressions results in which I repeat the specification described in equation 1.7 on the credit to the non-tradable sector broken down by firm size. The credit registry provides a categorical variable indicating the number of employees of the recepient firm. I split the credit to the non-tradable sector at a municipality level into three categories - credit to firms with less than 50 employees, firms with 50-200 employees and firms with >200 employees. The results show that the drop in lending

[22]The results also holds if we drop the municipalities in Tlaxcala and Puebla, states which form a part of Valle de Mexico, along with DF, Estado de Mexico and Morales, the largest metropolitan area in Mexico.

to the non-tradable sector is largely driven by firms with less than 50 employees. Does the lack of an effect on the credit issued to large non-tradable firms go against the hypothesis that the drop in lending to non-tradable firms was the result of local drops in household spending in high exposure municipalities? There are three reasons to believe this not to be the case. Firstly, I observe the drop in lending to the small non-tradable firms in the sub-sample of municipalities with a very limited direct exposure to Spanish banks. Secondly, I do not see any concurrent drops in lending to small firms in other sectors. Finally, it is possible that the larger firms in the non-tradable industries are better equipped to move their inventories across municipalities and are not non-tradable in the sense used in this paper.

1.6.5 Alternate definitions for non-tradable industries

In table 1.18, I show the effect of treatment on the growth of credit to the non-tradable sector based on alternate criteria for classifying 4-digit NAICS industries as non-tradable. I take the credit to the retail + restaurant industries as the base and add credit to firms in 5 different sub-sectors - Construction, Wholesale, Transportation, Professional Services and Other Services - to check whether the results of table 1.7 still hold after the inclusion of the individual sub-sectors. I do not find any treatment effect on the credit series created after the inclusion of these sub-sectors except in the case of the industries belonging to the transportation sub-sector. This result is consistent across the full sample and the restricted sample of municipalities. This suggests that the local demand effect identified in the natural experiment in Mexico holds for industries belonging to the retail, restaurant and transportation sub-sectors.

1.7 Conclusion

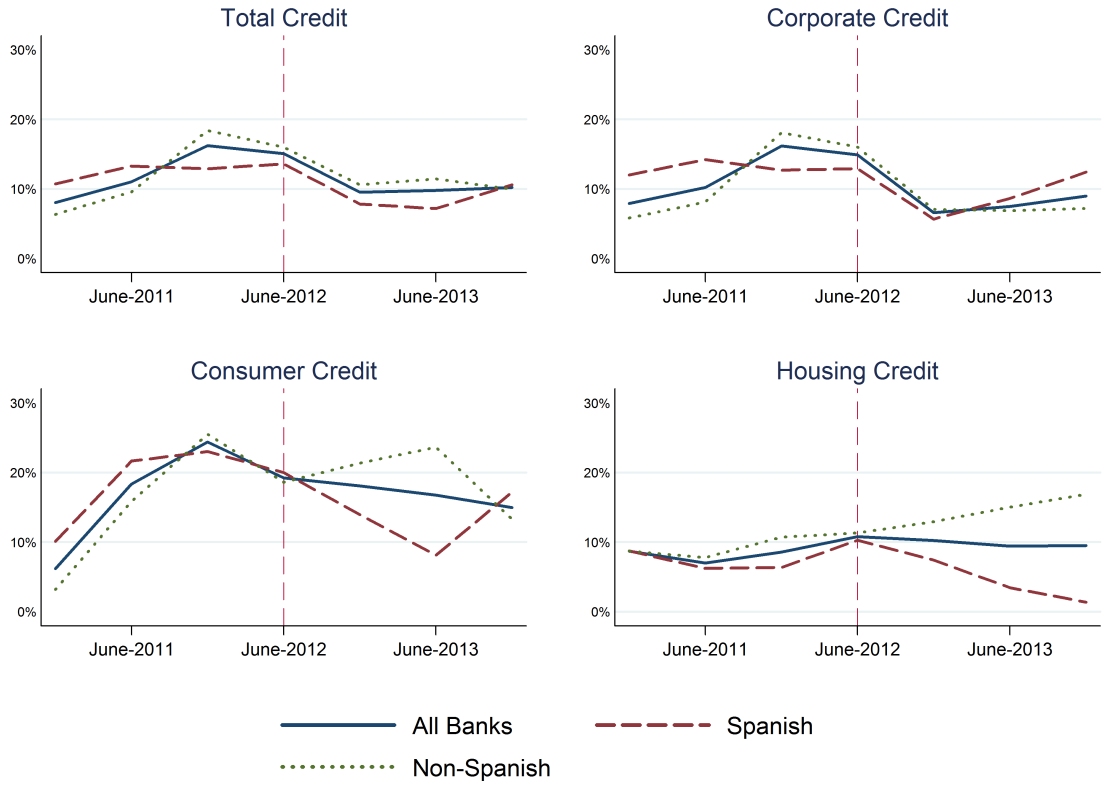
I identify an exogenous drop in household credit supply in Mexico resulting from the international transmission of a credit crunch in Spain connected to financial regulations. I use the variation in the treatment to this drop across Mexican municipalities as a natural experiment to study the effect of changes in household credit on investments in different sectors of the economy. My results show that the local demand effect of household credit that has been shown to exist by academic literature in a highly financialized economy like the US also exists in an under-financed, emerging economy like Mexico. While I focus on investments in the non-tradable sector as the outcome variable, the same shock can be used to study the impact on other outcome variables through similar natural experiments in other countries. This is indeed possible consid-

ering the global importance of Spanish banking groups such as BBVA and Santander. For instance, Santander has a significant presence in Brazil and Chile. The impact of the Spanish regulations on lending by Spanish banks in Brazil or Chile can provide additional evidence for the channels proposed in this paper.

In the theoretical section I show that, provided the interest rates are low enough, an increase in the level of household credit can shift the composition of economic activity in an economy towards the non-tradable sector. In my simple model, firms are Cobb-Douglas aggregators of capital and labour. There has been a recent push towards modeling economic activity as an aggregation of capital, labour and intermediates to better capture the complex, inter-connected nature of production in modern economies through input-output linkages. A systematic study of the effect of household credit on production through a model of input-output linkages will give us a more microscopic view of the channels through which greater household spending affects investment and production in specific sectors of the economy. I propose two reasons why such a study presents an interesting and potentially very insightful line of investigation. Firstly, any sectoral changes that are the result of movements in household spending can account for more frequent, longer and deeper recessions (as highlighted by Jorda et al. (2014, 2015)) resulting from sharp increases in household credit. Secondly, compositional changes in production might also raise concerns of lower productivity growth or secular stagnation through channels emphasized in Duarte and Restuccia (2010) and Perla et al. (2015). Eventually, I envisage models which theorize an optimal level of household credit to guide Government policy. The optimal level is likely to result from the trade-off between welfare gains from higher spending and welfare losses from shifts in sectoral composition as has been identified in my paper.

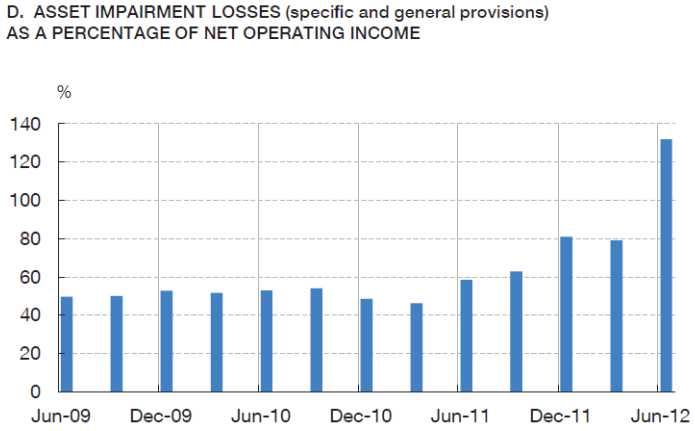
I also share suggestive evidence that the Spanish regulations did not lead to a credit supply shock to lending to firms by Spanish banks. I argue that Spanish banks may not have reduced lending to firms in Mexico since, on an average, credit to firms has lower capital requirements or is more profitable than household credit. While these are plausible arguments, data at a firm-level can provide evidence on whether there, indeed, was no direct supply shock to credit lending to firms. Such an analysis can be conducted using credit registry data at the highest level of disaggregation to study whether Spanish banks cut credit to firms in Mexico based on maturity, interest rate, risk or quality of collateral in response to the shock. Jimenez et al. (2012) is a recent contribution which uses firm-level data to study the effect of counter-cyclical loan loss provisions on lending to firms by Spanish banks in Spain. While data constraints have not allowed me to conduct a similar study on the effect of Spanish regulations on lending at a firm level in Mexico, such an analysis is earmarked for further inspection.

Figure 1.1: Growth in credit lending by Spanish and non-Spanish banks in Mexico



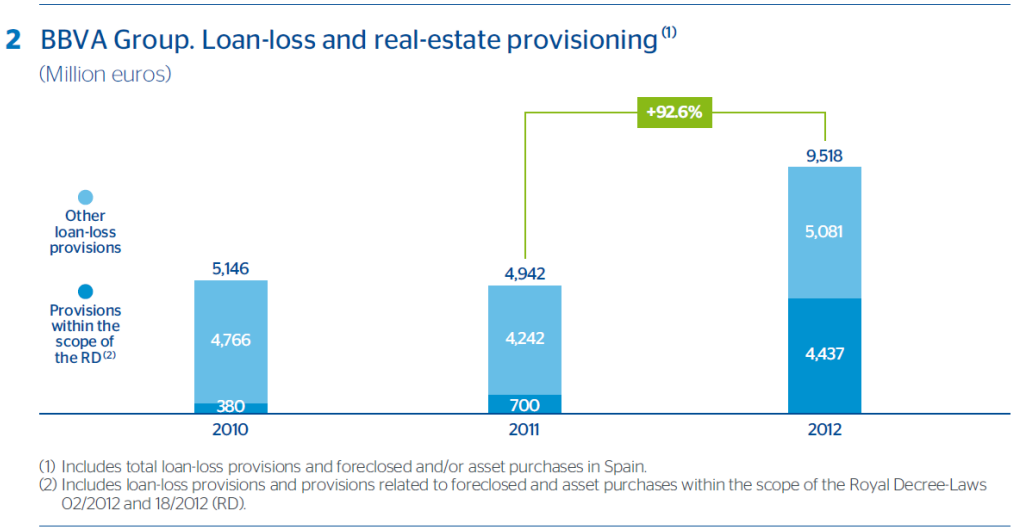
Note: This figure plots growth rates of credit issued by Spanish and non-Spanish banks in Mexico during December 2010 to December 2013. The growth rate is calculated against the level a year ago for the corresponding credit type. There is a sharp decline in the growth rate of lending to households by Spanish banks after June 2012 (lower panels). Top left panel shows that there is no such contrast in the aggregate growth rate of lending to firms by Spanish and non-Spanish banks.

Figure 1.2: Loan-loss provisions vs Net Operating Income in Spain



Source: Financial Stability Report, Banco de Espana, November 2012 (page 30). Note: This figure shows the sharp increase in the provisions held by Spanish banks as a percentage of net operating income in June 2012 as a consequence of the macroprudential regulations RDL 02/2012 and RDL 18/2012

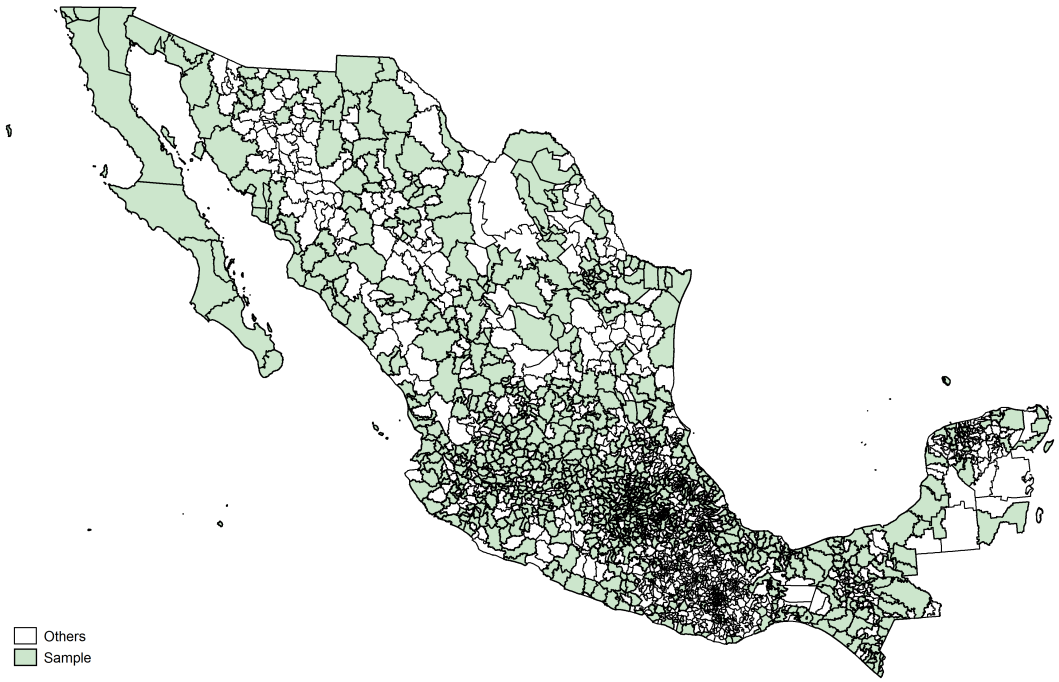
Figure 1.3: Loan-loss provisions by BBVA resulting from RD 02/2012 and RD 18/2012



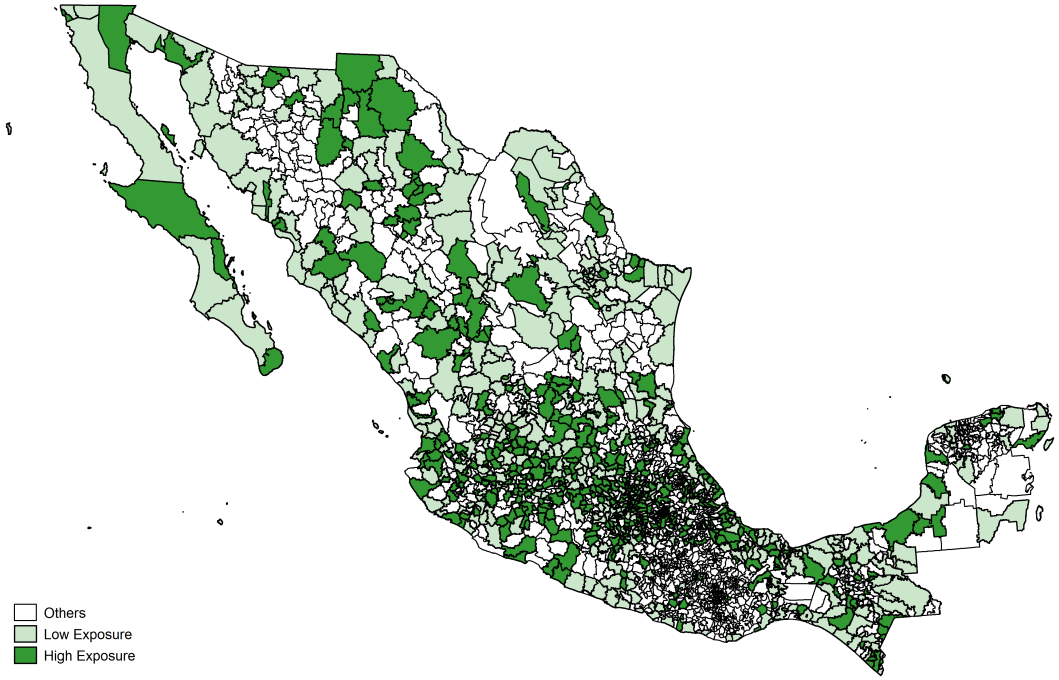
Source: BBVA in 2012, the BBVA banking group annual report for 2012 *(page 65). Note:* This figure shows the total burden of loan loss provisions imposed on BBVA by the regulations in 2012 (dark blue area in the bar for 2012).

Figure 1.4: Mexican municipalities covered by the database

(a) The full sample

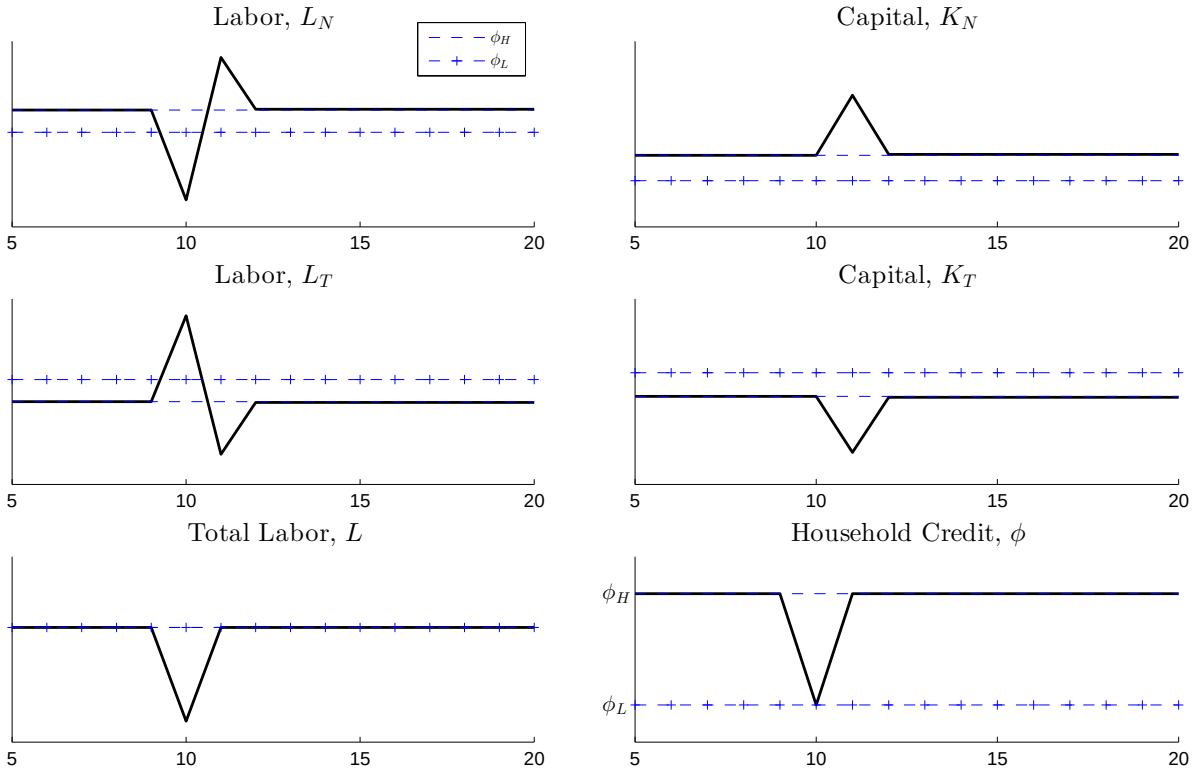


(b) Share of Spanish banks in household credit across the municipalities



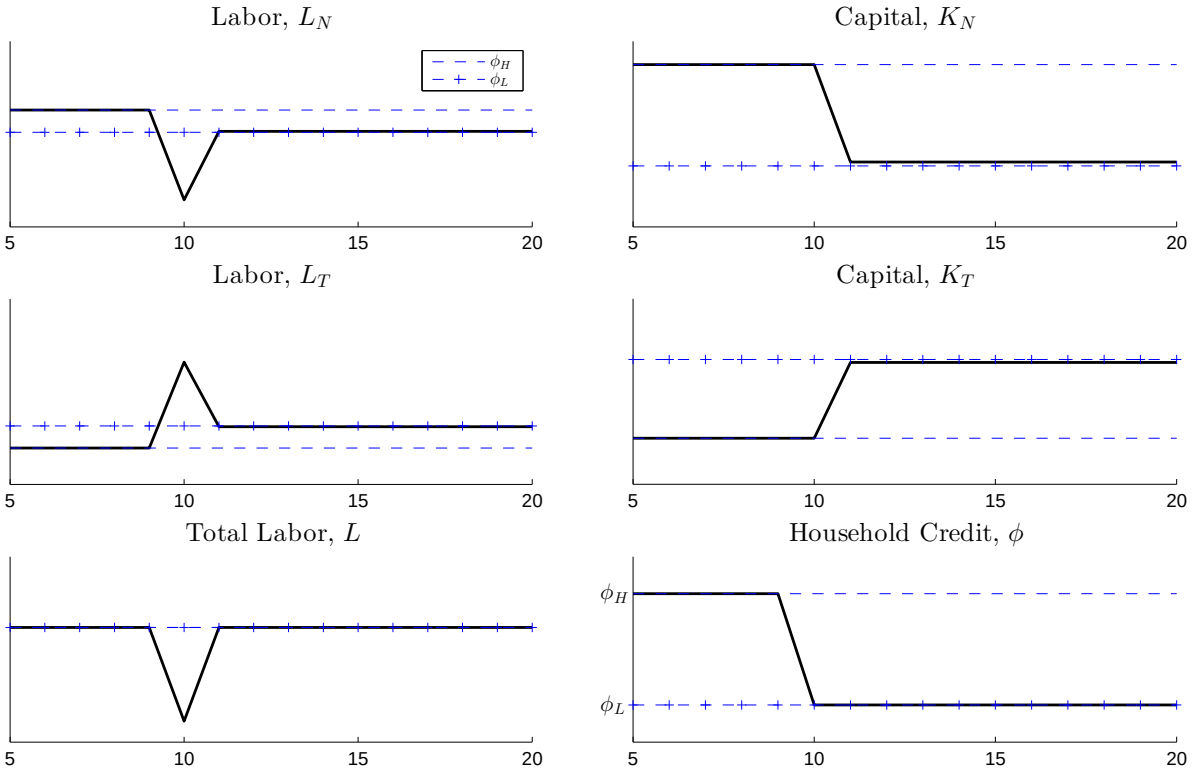
Note: The figure (a) shows the distribution of the 999 municipalities covered by the database. Figure (b) shows the spatial distribution of municipalities with high and low exposure to Spanish banks. High exposure municipalities are defined as those with a share of Spanish banks in household credit market higher than the median value in June 2011. The summary statistics for these 999 municipalities is presented in tables 3.

Figure 1.5: Effect of a shock leading to a temporary change in ϕ



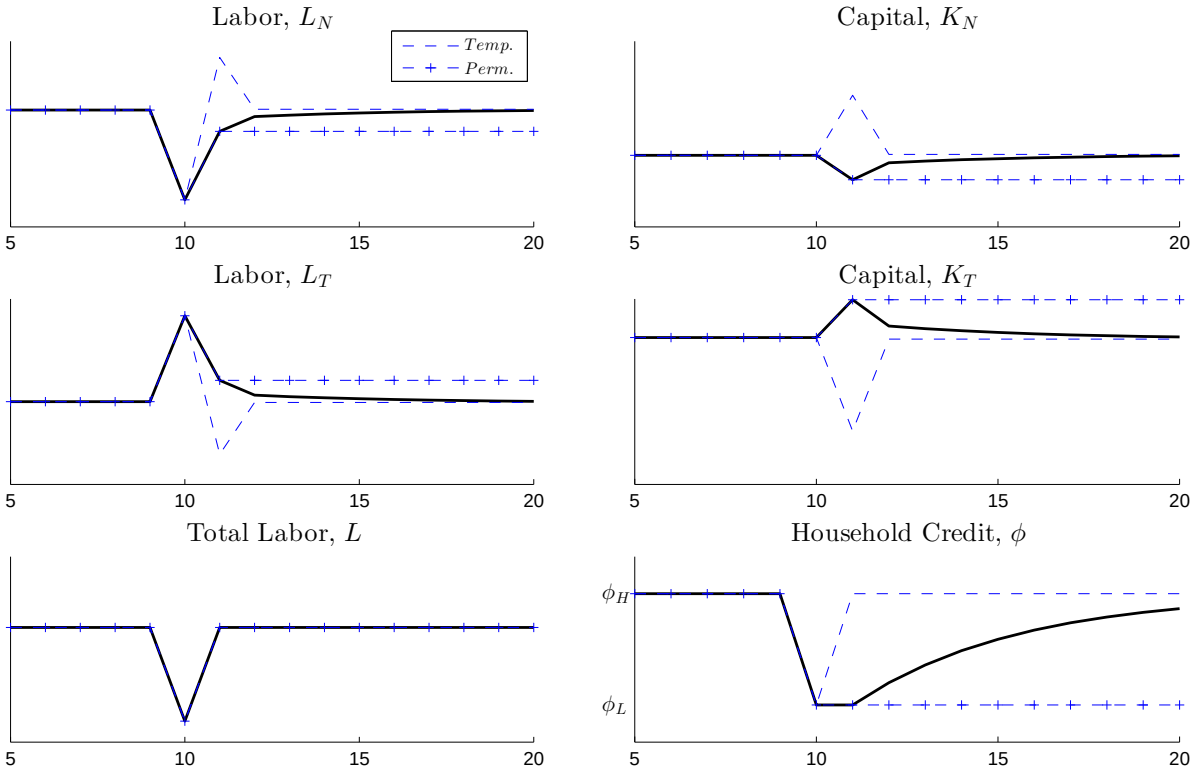
Note - This figure plots the effect of a temporary negative shock to household credit at $t = 10$ (bottom right panel). $\{L_T, L_N$ and $\{K_T, K_N\}$ refer to the labour and capital absorbed in the tradable and non-tradable sectors respectively in the municipality represented in the above simulation.

Figure 1.6: Effect of a shock leading to a permanent change in ϕ



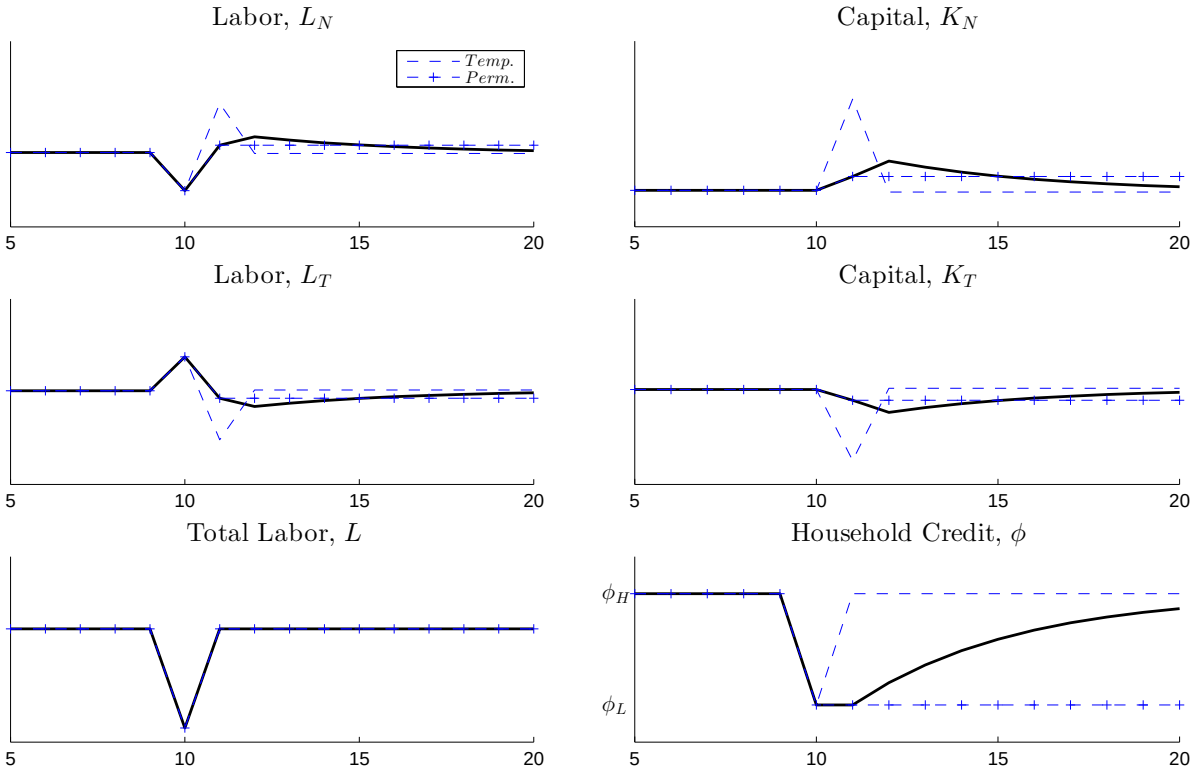
Note - This figure plots the effect of a permanent negative shock to household credit at $t = 10$ (bottom right panel). $\{L_T, L_N$ and $\{K_T, K_N\}$ refer to the labour and capital absorbed in the tradable and non-tradable sectors respectively in the municipality represented in the above simulation.

Figure 1.7: Effect of a temporary change in ϕ with persistence



Note - This figure plots the effect of a temporary negative shock to household credit with persistence at $t = 10$ (bottom right panel). $\{L_T, L_N$ and $\{K_T, K_N\}$ refer to the labour and capital absorbed in the tradable and non-tradable sectors respectively in the municipality represented in the above simulation. There is a drop in investments and labour allocated in the non-tradable until the level of household credit recovers back to the pre-shock level since the interest rates are assumed to be low.

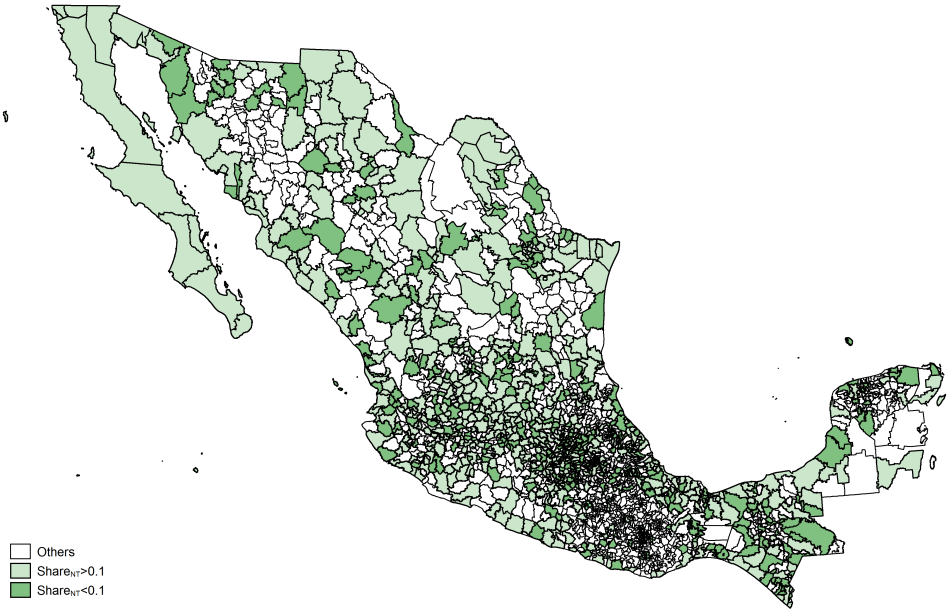
Figure 1.8: Effect of a temporary change in ϕ with persistence (case $R^* > 1$)



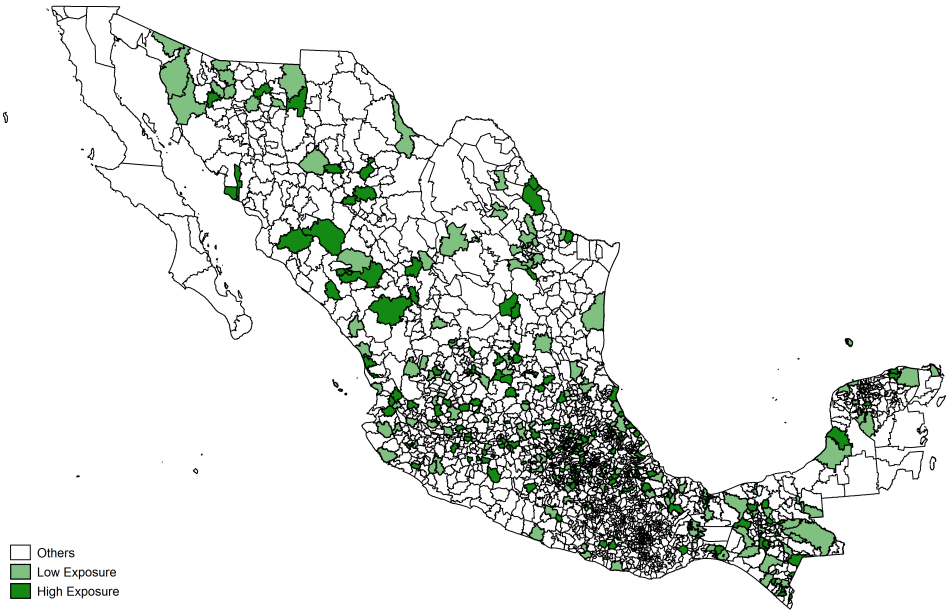
Note - This figure plots the effect of the temporary negative shock in figure 1.7 when interest rates are high. $\{L_T, L_N$ and $\{K_T, K_N\}$ refer to the labour and capital absorbed in the tradable and non-tradable sectors respectively in the municipality represented in the above simulation. There is an increase in investments and labour allocated in the non-tradable sector despite the fall in household credit since the low levels of household credit mean the employed workers have a higher spending power after clearing their debts from the previous period.

Figure 1.9: Sub-sample of municipalities with limited exposure to Spanish banks for non-tradable firms

(a) Sub-sample municipalities in darker green



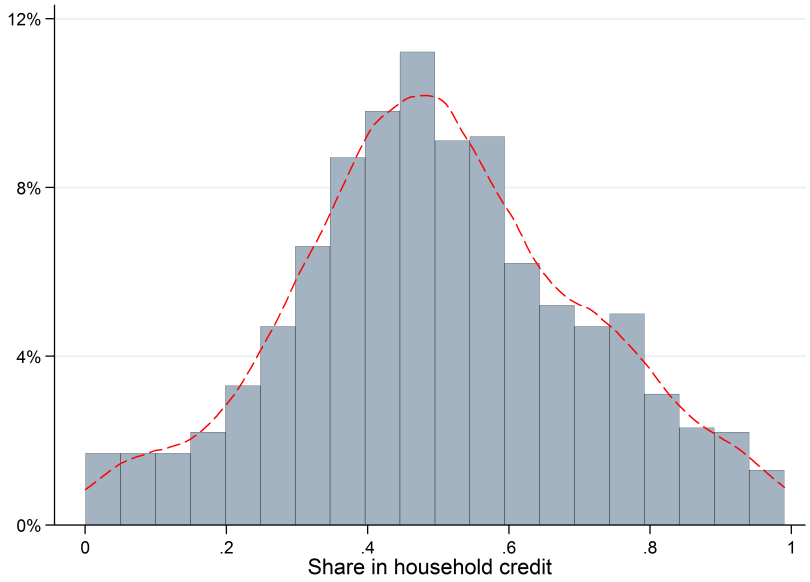
(b) Share of Spanish banks in household credit across the municipalities in the sub-sample



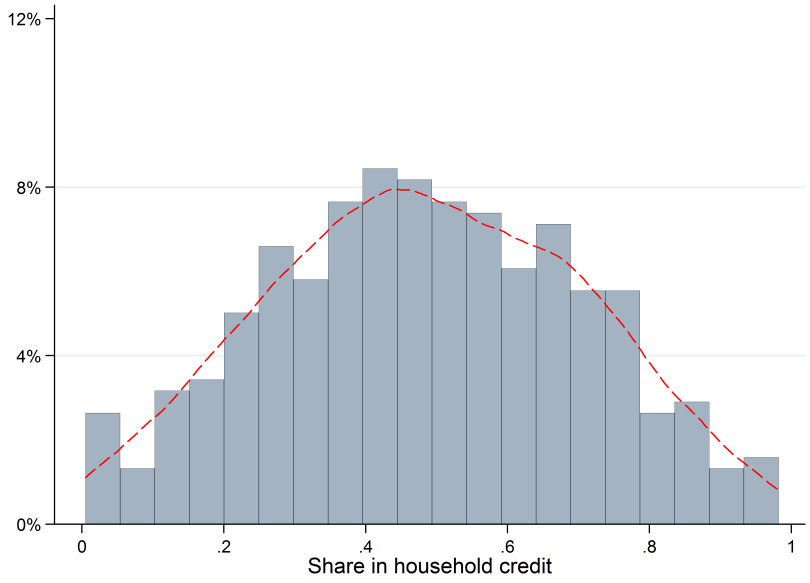
Note: The figure (a) shows the spatial presence of the 379 municipalities amongst the 999 municipalities of the sample which have a very limited presence of Spanish banks in the credit market for non-tradable firms. $Share_{NT}$ indicates the share of Spanish banks in the credit market for non-tradable firms. Figure (b) shows the spatial distribution of municipalities with high and low exposure to Spanish banks in the sub-sample of 379 municipalities. High exposure municipalities are defined as those with a share of Spanish banks in household credit market higher than the median value in June 2011.

Figure 1.10: Distribution of Spanish shares in household credit market across Mexican municipalities

(a) Full sample - 999 municipalities

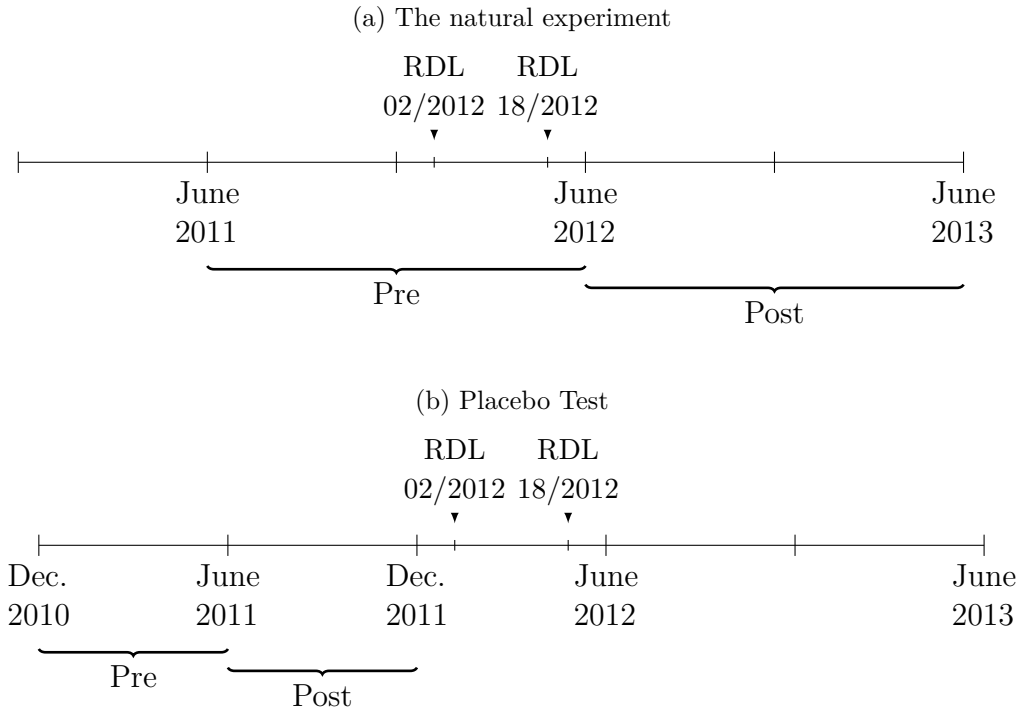


(b) Sub-sample - 379 municipalities



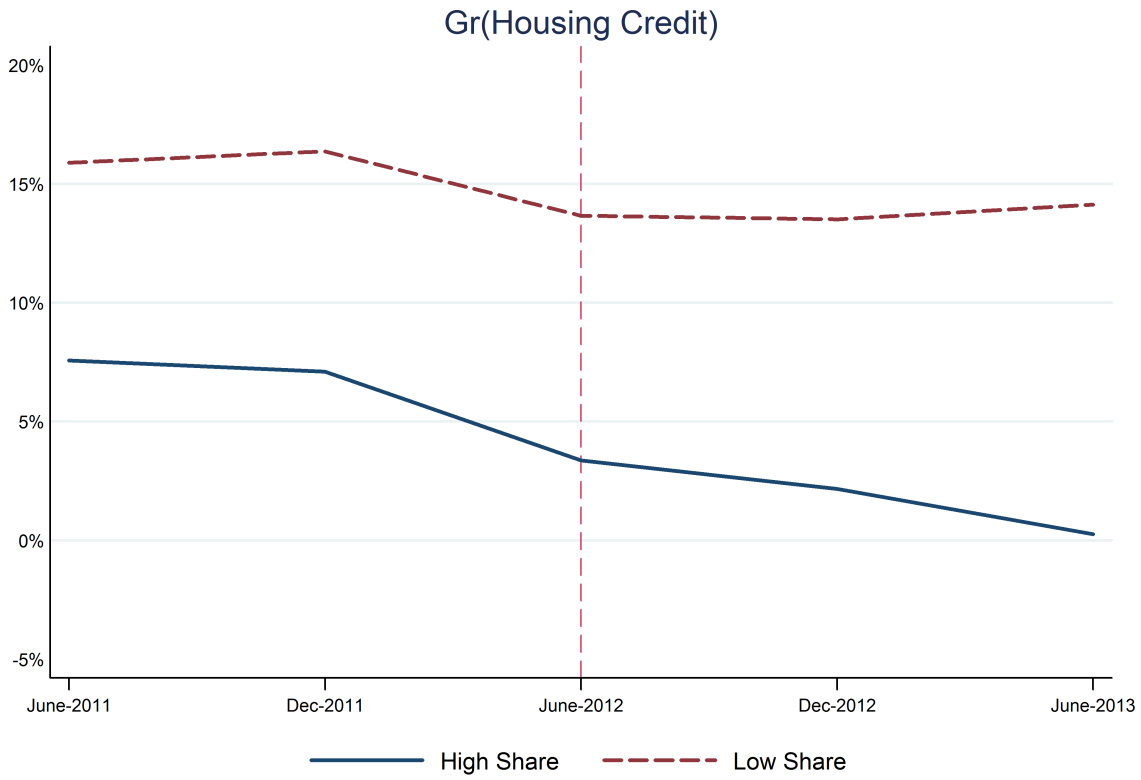
Note : These figures above show the distribution of Spanish shares in household credit markets across the Mexican municipalities for the entire sample (a) and the sub-sample of municipalities with a very low presence of Spanish banks in the non-tradable credit market (b). Restricting the sample to the sub-sample still presents a rich variation in the exposure to the financial shock as captured by the share of Spanish banks in the household credit market.

Figure 1.11: Experiment design



Note: The above figure shows a diagrammatic representation of the natural experiment. The Spanish regulations, RDL 02/2012 and RDL18/2012, were introduced in early February and May 2012. The supply shock to household credit is measured by comparing the growth in household credit across Mexican municipalities with different levels of exposure to the shock a year before and after June 2012 using a difference-in-difference specification. The placebo test is conducted using a hypothetical experiment in June 2011 to show that the exposure to Spanish banks does not predict different trends in the growth of household credit.

Figure 1.12: Parallel trends in growth of housing credit



Note: The above figure plots the growth rate for total housing credit in Mexican municipalities in high and low exposure to Spanish banks. High exposure municipalities are the ones in which the share of household credit issued by Spanish banks in June 2011 is in the top tercile of the distribution. Low exposure municipalities are the ones in which the share of household credit issued by Spanish banks in June 2011 is in the bottom tercile of the distribution.

Table 1.1: Aggregate consequences of drop in lending to households by Spanish banks in Mexico

(a) Share of household credit issued by Spanish banks in high- and low-share municipalities

	Jun-2011	Jun-2012	Jun-2013
High-Share Municipalities	55.8%	54.1%	48.9%
Low-Share Municipalities	36.5%	36.1%	33.6%

(b) Share of credit to the non-tradable industries in high- and low-share municipalities

	Jun-2011	Jun-2012	Jun-2013
High-Share Municipalities	38.6%	37.3%	34.9%
Low-Share Municipalities	39.8%	40.8%	39.1%

Note: Mexican municipalities are grouped into high- and low-share municipalities based on the share of household credit issued by Spanish banks at a municipality level in June 2012. We then plot the share of household credit issued by Spanish banks and the % of total corporate credit allocated to non-tradable industries from June 2011 to June 2013 in the two sub-groups. The non-tradable industries includes those belonging to the retail sector, restaurants and the construction sector.

Table 1.2: Shares in credit markets for commercial banks in Mexico in June 2012

(a) Share of Spanish and non-Spanish banks

	Mortgages	Consumer Credit	Corp. Cred.	Total Cred.
Spanish	48%	44%	35%	38%
Non-Spanish	52%	56%	65%	62%

(b) Share of mortgage credit issued by bank

Bank	Share	Maturity (in month)	Avg. Int Rate
BBVA Bancomer	36.7%	229	11.1
Santander	11.7%	207	10.4
Banamex	15.2%	212	10.4
HSBC	4.7%	232	10.2
Scotiabank	11.3%	222	10.5
Banorte/Ixe	15.8%	222	10.4
Inbursa	0.3%	167	10.0

(c) Share of corporate credit issued by bank

Bank	Share	Maturity (in months)	Avg. Int Rate	Working Credit %
BBVA Bancomer	20.0%	38	7.4	90%
Santander	16.0%	39	7.5	77%
Banamex	14.9%	37	6.8	90%
HSBC	8.3%	36	7.5	94%
Scotiabank	3.9%	35	6.6	55%
Banorte/Ixe	12.2%	62	8.3	85%
Inbursa	8.3%	57	7.4	100%

Note: Table (a) shows the share of Spanish and non-Spanish banks in different credit markets at a Mexico level in June 2012. Table (b) shows the market share, average maturity and average interest rate by bank in the mortgage market. Table (b) shows the market share, average maturity, average interest and the share of credit issued as working capital rate by bank in the credit market for firms. *Source - CNBV, R-04 credit registry.*

Table 1.3: Summary statistics of sectors by classifying criterion

		Non-tradable	tradable	Construction	Others
Criterion A	No. of sectors	24	81	22	171
	Labour Share	28.1%	21.8%	8.7%	41.4%
Criterion B	No. of sectors	32	74	22	170
	Labour Share	33.2%	7.3%	8.7%	46%

Note - This table shows the number of industries, and their corresponding labour share, comprising the different sectors based on the two classification criteria. *Source - Census 2009.*

Table 1.4: Summary statistic for municipality characteristics

	count	mean	sd	p10	p90
Population, 2013	999	103446	204974	9898	228190
Area in sq. km.	999	1193	2830	65	2722
GDP p.c., 2010	999	11131	4655	6265	16513
Number of accounts, 2013	999	3995	5031	457	8386
Number of ATM transactions, 2013	999	6633	8100	0	15048
Number of credit cards, 2013	999	1156	2223	165	2463
Access to credit	count	mean	sd	p10	p90
Household credit p.c.[a]	999	6642	20745	910	11326
Corporate credit p.c.[a]	999	7222	79638	71	9562
Total credit p.c.[a]	999	13865	92383	1184	20344
Household credit/GDP[b]	999	0.111	0.525	0.008	0.127
Corporate credit/GDP[b]	999	0.088	0.948	0.001	0.117
Total credit/GDP[b]	999	0.199	1.294	0.011	0.253
Δ log Household credit	999	0.20	0.18	0.00	0.38
Δ log Corporate credit	998	0.29	0.64	-0.26	0.86
Δ log Credit to non-trad. industries	999	0.27	0.77	-0.37	1.18
Δ log Credit to trad. industries	687	0.31	1.18	-0.51	1.26
Exposure to Spanish banks	count	mean	sd	p10	p90
Share in household credit	999	0.50	0.21	0.24	0.78
Share in corporate credit	999	0.33	0.28	0.00	0.77
Share in credit to non-trad. industries	999	0.33	0.35	0.00	0.99
Share in credit to trad. industries	707	0.40	0.37	0.00	1.00
Share in total credit	999	0.46	0.20	0.20	0.73

Source: CNBV, Census 2009, UN Reports, R-04

Note: This table shows the summary statistic for the 999 municipalities covered in the credit database.

Table 1.5: Summary statistic for municipality characteristics

	count	mean	sd	p10	p90
Population, 2013	379	44448	72675	7019	88286
Area in sq. km.	379	870	1557	56	1902
GDP p.c., 2010	379	9824	3875	5800	14556
Number of accounts, 2013	379	2252	3018	314	5982
Number of ATM transactions, 2013	379	3842	5414	0	9858
Number of credit cards, 2013	379	655	721	124	1637
Access to credit	count	mean	sd	p10	p90
Household credit p.c.[a]	379	4967	17687	725	6812
Corporate credit p.c.[a]	379	2671	11723	31	5590
Total credit p.c.[a]	379	7638	24489	854	13459
Household credit/GDP[b]	379	0.084	0.315	0.005	0.111
Corporate credit/GDP[b]	379	0.043	0.175	0.000	0.084
Total credit/GDP[b]	379	0.127	0.427	0.008	0.219
Δ log Household credit	379	0.23	0.20	-0.00	0.44
Δ log Corporate credit	379	0.33	0.80	-0.44	1.21
Δ log Credit to non-trad. industries	379	0.24	0.90	-0.56	1.36
Δ log Credit to trad. industries	185	0.38	1.59	-0.51	1.59
Exposure to Spanish banks	count	mean	sd	p10	p90
Share in household credit	379	0.48	0.22	0.19	0.78
Share in corporate credit	379	0.18	0.25	0.00	0.58
Share in credit to non-trad. industries	379	0.01	0.03	0.00	0.05
Share in credit to trad. industries	197	0.29	0.36	0.00	1.00
Share in total credit	379	0.43	0.21	0.14	0.73

Sub-sample municipalities with Share$_{NT}$<0.1

Note: This table shows the summary statistic for the 379 municipalities in the credit database with limited exposure to Spanish banks for firms in the non-tradable sector.

Table 1.6: Effect of Spanish regulations on household credit lending in Mexico

(a) Regressions based on the full sample

VARIABLES	(1) Δ log (Household Credit)	(2) Δ log (Housing Credit)	(3) Δ log (Consumer Credit)
Post*Spanish Share$_{2011}$	-0.267***	-0.258***	-0.209***
	(0.0370)	(0.0712)	(0.0436)
Observations	1,998	1,908	1,998
Number of municipalities	999	960	999
R-squared	0.684	0.660	0.624
Mun. Fixed-effects	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

(b) Regressions based on the sub-sample with low share of Spanish banks in the non-tradable credit market

VARIABLES	(1) Δ log (Household Credit)	(2) Δ log (Housing Credit)	(3) Δ log (Consumer Credit)
Post*Spanish Share$_{2011}$	-0.228***	-0.423***	-0.120*
	(0.0605)	(0.124)	(0.0620)
Observations	758	701	758
Number of municipalities	379	354	379
R-squared	0.626	0.594	0.624
Mun. Fixed-effects	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

Note: The tables above show regression results of changes in log-levels of credit to households on the treatment variable $Post \cdot Spanish\ Share_{2011}$ in the presence of municipality and time fixed effects. Data from two periods are used - June 2012 and June 2013. The variable *Post* indicates June 2013 and the exposure to Spanish banks is measured by the municipality level share of Spanish banks in the household credit market in June 2011, almost an year prior to the introduction of Spanish regulations. The top table shows results for the full sample and the bottom table shows the results for the sub-sample of municipalities with very low exposure to Spanish banks for non-tradable firms. The municipality fixed effect controls for any municipality level trends and the coefficient of the treatment variable indicates a drop in the growth of household credit in municipalities with a high Spanish share.

Table 1.7: Effect of Spanish regulations on sector level credit

(a) Full-sample

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Δ log(Non-trad.)		Δ log(Non-trad.+Const.)		Δ log(Tradable)	
	OLS	WLS	OLS	WLS	OLS	WLS
Post*Spanish Share$_{2011}$	-0.440**	-0.436*	-0.287*	-0.219	-0.0560	0.0382
	(0.186)	(0.226)	(0.173)	(0.165)	(0.249)	(0.274)
Observations	1,998	1,998	1,998	1,998	1,741	1,741
Number of municipalities	999	999	999	999	933	933
R-squared	0.432	0.461	0.445	0.479	0.514	0.496
Mun. Fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

(b) Sub-sample

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Δ log(Non-trad.)		Δ log(Non-trad.+Const.)		Δ log(Tradable)	
	OLS	WLS	OLS	WLS	OLS	WLS
Post*Spanish Share$_{2011}$	-0.797**	-1.035**	-0.470	-0.437	-0.461	-0.396
	(0.321)	(0.464)	(0.305)	(0.411)	(0.593)	(0.921)
Observations	758	758	758	758	424	424
Number of municipalities	379	379	379	379	233	233
R-squared	0.422	0.442	0.407	0.391	0.544	0.427
Mun. Fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

Note: The tables above show regression results of changes in log-levels of credit to specific sectors on the treatment variable $Post \cdot Spanish\ Share_{2011}$ in the presence of municipality and time fixed effects. Data from two periods are used - June 2012 and June 2013. The variable *Post* indicates June 2013 and the exposure to Spanish banks is measured by the municipality level share of Spanish banks in the household credit market in June 2011, almost an year prior to the introduction of the Spanish regulations. The top table shows results for the full sample and the bottom table shows the results for the sub-sample of municipalities with limited exposure to Spanish banks for non-tradable firms. I report OLS and WLS results for the changes in lending to firms in different sectors as explained by the exposure to the Spanish banks.

Table 1.8: Elasticity of investments in the non-tradable sector to changes in household credit for the full sample

(a) First Stage

VARIABLES	(1) Δ log (Household Credit)	(2) Δ log (Household Credit)	(3) Δ log (Household Credit)
Post*Spanish Share$_{2011}$	-0.267***	-0.267***	-0.245***
	(0.0370)	(0.0370)	(0.0436)
Observations	1,998	1,998	1,336
Number of municipalities	999	999	667

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

(b) Second Stage

VARIABLES	(1) Δ log (Non-trad.)	(2) Δ log (Non-trad. + Const.)	(3) Δ log (Tradable)
	2SLS	2SLS	2SLS
Δ log (Household Credit)	1.649**	1.077*	0.135
	(0.711)	(0.651)	(1.262)
Observations	1,998	1,998	1,336
Number of municipalities	999	999	668
F-stat	52.07	52.07	26.15
Mun. Fixed-effects	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

Note: The tables above show IV regression results of changes in log-levels of credit at a sector level on changes in log-levels of credit to households for the entire sample of 999 municipalities in Mexico. The changes in log-levels of household credit are instrumented by the treatment variable based on the municipality level shares of Spanish banks in the household credit market in June 2011. Data from two periods are used - June 2012 and June 2013. The variable *Post* indicates June 2013. The top table shares the first stage results which show a very high F-stat and the bottom table shows the elasticity of investments in different sectors to changes in access to household credit at a municipality level.

Table 1.9: Elasticity of investments in the non-tradable sector to changes in household credit for the sub-sample

(a) First Stage

VARIABLES	(1) Δ log (Household Credit)	(2) Δ log (Housing Credit)	(3) Δ log (Consumer Credit)
Post*Spanish Share$_2$011	-0.228***	-0.228***	-0.265**
	(0.0605)	(0.0605)	(0.110)
Observations	758	758	348
Number of municipalities	379	379	174

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

(b) Second Stage

VARIABLES	(1) Δ log (Non-trad.)	(2) Δ log (Non-trad. + Const.)	(3) Δ log (Tradable)
	2SLS	2SLS	2SLS
Δ log (Household Credit)	3.488**	2.059	2.487
	(1.708)	(1.446)	(2.603)
Observations	758	758	348
Number of municipalities	379	379	174
F-stat	14.28	14.28	5.83
Mun. Fixed-effects	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

Note: The tables above show IV regression results of changes in log-levels of credit at a sector level on changes in log-levels of credit to households for the sub-sample sample of 379 municipalities in Mexico with a very low exposure to the presence of Spanish banks in the non-tradable sector. The changes in log-levels of household credit are instrumented by the treatment variable based on the municipality level shares of Spanish banks in the household credit market in June 2011. Data from two periods are used - June 2012 and December 2013. The variable *Post* indicates June 2013. The top table shares the first stage results which show a high F-stat and the bottom table shows the elasticity of investments in different sectors to changes in access to household credit at a municipality level.

Table 1.10: Effect of Spanish regulations on the average interest rate of the marginal credit issued to sectors

(a) Full sample

VARIABLES	(1) Avg. Int. (Non-Trad.)	(2) Avg. Int. (Tradable)
Post*Spanish Share$_{2011}$	-2.471**	-0.946
	(1.034)	(1.433)
Observations	1,361	989
Number of municipalities	811	604
R-squared	0.837	0.878
Mun. Fixed-effects	Yes	Yes
Time Fixed-effects	Yes	Yes

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(b) Sub-sample

VARIABLES	(1) Avg. Int. (Non-Trad.)	(2) Avg. Int. (Tradable)
Post*Spanish Share$_{2011}$	-4.257**	-1.972
	(1.820)	(1.712)
Observations	408	254
Number of municipalities	273	170
R-squared	0.819	0.919
Mun. Fixed-effects	Yes	Yes
Time Fixed-effects	Yes	Yes

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: The tables above show difference-in-difference regression results of the average interest rate of marginal credit issued at a sectoral level in December 2012 and June 2011 on the treatment variable $Post \cdot Spanish\ Share_{2011}$. The variable *Post* indicates December 2012 and the exposure to Spanish banks is measured by the municipality level share of Spanish banks in the household credit market in June 2011. The top table shows results for the full sample and the bottom table shows the results for the sub-sample of municipalities with very low exposure to Spanish banks for non-tradable firms. Results show a decline in the interest rate charged for newly issued credit to non-tradable firms in high Spanish share municipalities.

Table 1.11: Effect of Spanish regulations on credit lending in Mexico - Placebo

VARIABLES	(1)	(2)	(3)	(4)
	Δ log (Housing Credit)		Δ log (Non-trad.)	
	Full-sample	Sub-sample	Full-sample	Sub-sample
Post-Placebo*Spanish Share$_{1106}$	0.117	0.141	0.209	0.145
	(0.114)	(0.177)	(0.331)	(0.541)
Observations	1,889	689	1,959	728
Number of municipalities	951	350	998	379
R-squared	0.551	0.567	0.464	0.471
Mun. Fixed-effects	Yes	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

Note: The tables above show regression results of changes in log-levels of credit to households on a placebo treatment variable $Post - Placebo \cdot Spanish\ Share_{2011}$ in the presence of municipality and time fixed effects. Data from two periods are used - June 2011 and December 2011. The variable $Post - Placebo$ indicates December 2011 and checks for any evidence of treatment assuming the experiment took place in June 2011. The exposure to Spanish banks is measured by the municipality level share of Spanish banks in the household credit market in June 2011. The regression specification matches the one used for tables 1.6 and 1.7 and the treatment variable does not explain any changes in lending to households or to the nontradable sector in the placebo experiment.

Table 1.12: Effect of Spanish regulations on the average interest rate of the marginal credit issued by sector - Placebo

(a) Full-sample

VARIABLES	(1) Avg. Int. (Non-Trad.)	(2) Avg. Int. (Non-Trad.+ Const.)	(3) Avg. Int. (Tradable)
Post*Spanish Share$_{2011}$	-0.785	-0.492	2.576*
	(1.099)	(1.134)	(1.356)
Observations	1,359	1,481	978
Number of municipalities	818	868	594
R-squared	0.811	0.661	0.828
Mun. Fixed-effects	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

(b) Sub-sample

VARIABLES	(1) Avg. Int. (Non-Trad.)	(2) Avg. Int. (Non-Trad. + Const.)	(3) Avg. Int. (Tradable)
Post*Spanish Share$_{2011}$	-0.903	-0.145	0.546
	(2.124)	(1.861)	(1.809)
Observations	402	459	238
Number of municipalities	268	297	157
R-squared	0.788	0.796	0.904
Mun. Fixed-effects	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

Note: The tables above show regression results of the average interest rate of marginal credit issued at a sectoral level in December 2013 and June 2011 on the treatment variable $Post - Placebo \cdot Spanish\ Share_{2011}$. The variable $Post - Placebo$ indicates December 2013 and the exposure to Spanish banks is measured by the municipality level share of Spanish banks in the household credit market in June 2011. Results show that there was no significant difference in the average interest rate of the marginal credit issued to firms in the non-tradable and tradable sector at a municipality level in December 2013 when compared to the levels in June 2011. This is the placebo tests for the results in table 1.10 which show a drop in the average interest rate of marginal credit issued to non-tradable firms in high Spanish exposure municipalities in December 2012 vs the levels in June 2011.

Table 1.13: Effect of Spanish regulations on sector level credit - WLS results

(a) Full-sample

VARIABLES	(1)	(2)	(3)	(4)	(5)
	Δ log (Non-trad.)				
	OLS	WLS			
		Pop.	GDP p.c.	GDP	Fin.
Post*Spanish Share$_{2011}$	-0.440**	-0.436*	-0.469**	-0.420	-0.440**
	(0.186)	(0.226)	(0.185)	(0.266)	(0.186)
Observations	1,998	1,998	1,998	1,998	1,998
Number of municipalities	999	999	999	999	999
R-squared	0.432	0.461	0.443	0.475	0.432
Mun. Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

(b) Sub-sample

VARIABLES	(1)	(2)	(3)	(4)	(5)
	Δ log (Non-trad.)				
	OLS	WLS			
		Pop.	GDP p.c.	GDP	Fin.
Post*Spanish Share$_{2011}$	-0.797**	-1.035**	-0.776**	-0.985**	-0.797**
	(0.321)	(0.464)	(0.339)	(0.483)	(0.321)
Observations	758	758	758	758	758
Number of municipalities	379	379	379	379	379
R-squared	0.422	0.442	0.427	0.448	0.422
Mun. Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

Note: The tables above show regression results of changes in log-levels of credit to specific sectors on the treatment variable $Post \cdot Spanish\ Share_{2011}$ in the presence of municipality and time fixed effects. Data from two periods are used - June 2012 and June 2013. The variable *Post* indicates June 2013 and the exposure to Spanish banks is measured by the municipality level share of Spanish banks in the household credit market in June 2011. The top table shows results for the full sample and the bottom table shows the results for the sub-sample of municipalities with very low exposure to Spanish banks for non-tradable firms. WLS results are presented in columns 2 to 5 by weighting observations at a municipality level by municipality level population, GDP per capita, GDP and an index of financial access given by the number of branches at the municipality level per 10,000 residents. The regression coefficient is robust to weighting the observations across these multiple dimensions.

Table 1.14: Effect of Spanish regulations on credit lending in Mexico - Placebo

(a) Full-sample

VARIABLES	(1)	(2)	(3)	(4)	(5)
	Δ log (Non-trad.)				
	OLS	WLS	ex-DF	ex-DF/MX/MO	Area>200 sq. km.
Post*Spanish Share$_{2011}$	-0.440**	-0.436*	-0.433**	-0.427**	-0.435**
	(0.186)	(0.226)	(0.188)	(0.197)	(0.214)
Observations	1,998	1,998	1,966	1,728	1,400
Number of municipalities	999	999	983	864	700
R-squared	0.432	0.461	0.431	0.439	0.460
Mun. Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

(b) Sub-sample

VARIABLES	(1)	(2)	(3)	(4)	(5)
	Δ log (Non-trad.)				
	OLS	WLS	ex-DF	ex-DF/MX/MO	Area>200 sq. km.
Post*Spanish Share$_{2011}$	-0.797**	-1.035**	-0.798**	-0.809**	-0.679*
	(0.321)	(0.464)	(0.321)	(0.329)	(0.379)
Observations	758	758	754	662	490
Number of municipalities	379	379	377	331	245
R-squared	0.422	0.442	0.422	0.440	0.459
Mun. Fixed-effects	Yes	Yes	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

Note: The tables above show regression results of changes in log-levels of credit to non-tradable sectors by firm-size on the treatment variable $Post \cdot Spanish\ Share_{2011}$ and in the presence of municipality and time fixed effects. Data from two periods are used - June 2012 and June 2013. The variable *Post* indicates June 2013 and the exposure to Spanish banks is measured by the municipality level share of Spanish banks in the household credit market in June 2011. The top table shows results for the full sample and the bottom table shows the results for the sub-sample of municipalities with very low exposure to Spanish banks for non-tradable firms. I find that the OLS and WLS coefficients are robust to dropping the observations of municipalities comprising Distrito Federal (DF or Mexico City), or that of municipalities in and around Distrito Federal (belonging to the states DF, Mexico and Morales). The results are also robust to restricting the regression to municipalities with a geographical expanse greater than 200 sq. km.

Table 1.15: Effect of Spanish regulations on lending to non-tradable sector by firm-size

(a) Full sample

	(1)	(2)	(3)
VARIABLES		Δ log (Non-trad.)	
Size, # of emp.	1-50	50-200	>200
Post*Spanish Share_{2011}	-0.479**	0.186	0.556
	(0.195)	(0.382)	(1.235)
Observations	1,978	519	218
Number of municipalities	991	266	113
R-squared	0.436	0.330	0.691
Mun. Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

(b) Sub-sample

	(1)	(2)	(3)
VARIABLES		Δ log (Non-trad.)	
Size, # of emp.	1-50	50-200	>200
Post*Spanish Share_{2011}	-0.680**	-1.080	-2.236
	(0.337)	(1.121)	(1.780)
Observations	750	100	28
Number of municipalities	376	52	15
R-squared	0.433	0.292	0.894
Mun. Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes

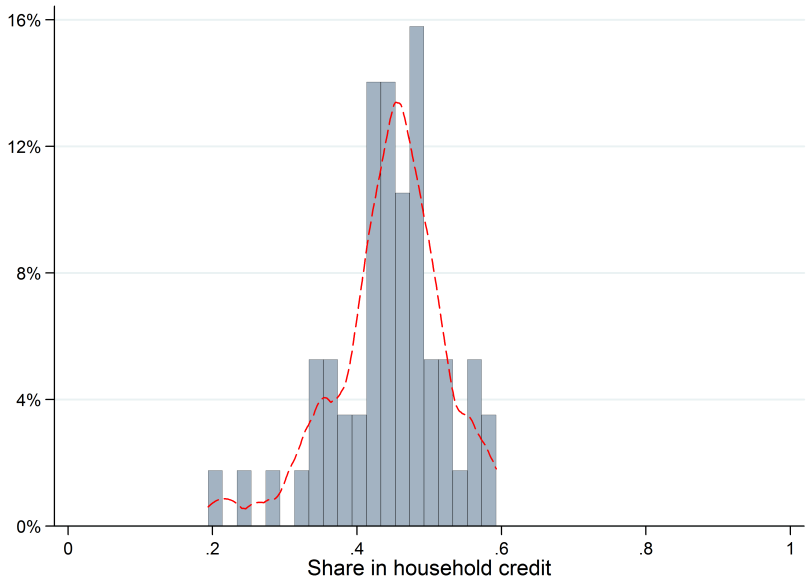
Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

Note: The tables above show regression results of changes in log-levels of credit to non-tradable sectors by firm-size on the treatment variable $Post \cdot Spanish\ Share_{2011}$ and in the presence of municipality and time fixed effects. Data from two periods are used - June 2012 and June 2013. The variable *Post* indicates June 2013 and the exposure to Spanish banks is measured by the municipality level share of Spanish banks in the household credit market in June 2011. The top table shows results for the full sample and the bottom table shows the results for the sub-sample of municipalities with very low exposure to Spanish banks for non-tradable firms. I find that the drop in lending to the non-tradable sector is concentrated in firms with 1-50 employees. The credit to larger firms is unaffected by the exposure to Spanish banks.

1.8 Empirical Appendix

1.8.1 Results using metropolitan area credit aggregates

Figure 1.13: Distribution of Spanish shares in household credit market across Mexican metropolitan areas



Note : The figures above show the distribution of Spanish shares in household credit markets across the Mexican metropolitan areas

Table 1.16: Effect of Spanish regulations on household credit lending in Mexican metropolitan areas

VARIABLES	(1) Gr(Household Credit)	(2) Gr(Housing Credit)	(3) Gr(Consumer Credit)
Post*Spanish Share$_{2011}$	-0.0770	-0.383*	0.0759
	(0.142)	(0.218)	(0.160)
Observations	114	114	114
Number of metropolitan areas	57	57	57
R-squared	0.593	0.732	0.499
Mun. Fixed-effects	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes

Clustered standard errors at a metro. area

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

Note: The tables above show regressions results of changes in log-levels of credit to households on the treatment variable $Post \cdot Spanish\ Share_{2011}$ in the presence of metropolitan area and time fixed effects. Data from two periods are used - June 2012 and June 2013. The variable *Post* indicates June 2013 and the exposure to Spanish banks is measured by the municipality level share of Spanish banks in the household credit market in June 2011. The metropolitan area fixed effect controls for any municipality level trends.

Table 1.17: Effect of Spanish regulations on sectoral credit lending in Mexican metropolitan areas

VARIABLES	(1) Δ log (Non-trad.)	(2) Δ log (Non-trad. + Const.)	(3) Δ log (Tradable)
Post*Spanish Share$_{2011}$	-0.877	0.836*	-0.818
	(0.737)	(0.467)	(0.896)
Observations	114	114	114
Number of metropolitan areas	57	57	57
R-squared	0.435	0.457	0.420
Mun. Fixed-effects	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes

Clustered standard errors at a metro. area
*** p<0.01, ** p<0.05, * p<0.1

Note: The tables above show regression results of changes in log-levels of sectoral credit on the treatment variable $Post \cdot Spanish\ Share_{2011}$ in the presence of metropolitan area and time fixed effects. Data from two periods are used - June 2012 and June 2013. The variable *Post* indicates June 2013 and the exposure to Spanish banks is measured by the share of Spanish banks in the household credit market at the level of the metropolitan area in June 2011, almost an year prior to the introduction of Spanish regulations. The metropolitan area fixed effect controls for any municipality level trends.

1.8.2 Alternative definitions of non-tradable sectors

Table 1.18: Effect of Spanish regulations on sector level credit

(a) Full-sample

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Δ log (Non-trad. + ...)					
	-	Const.	Wholesale	Trans.	Prof. Services	Other Services
Post*Spanish Share$_{2011}$	-0.440**	-0.287*	-0.140	-0.463**	-0.0857	-0.304*
	(0.186)	(0.173)	(0.180)	(0.180)	(0.174)	(0.182)
Observations	1,998	1,998	1,998	1,998	1,996	1,998
Number of municipalities	999	999	999	999	999	999
R-squared	0.432	0.445	0.410	0.434	0.462	0.416
Mun. Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

(b) Sub-sample

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Δ log (Non-trad. + ...)					
	-	Const.	Wholesale	Trans.	Prof. Services	Other Services
Post*Spanish Share$_{2011}$	-0.797**	-0.470	-0.363	-0.820**	-0.428	-0.621*
	(0.321)	(0.305)	(0.290)	(0.317)	(0.280)	(0.325)
Observations	758	758	758	758	758	758
Number of municipalities	379	379	379	379	379	379
R-squared	0.422	0.407	0.409	0.418	0.464	0.397
Mun. Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

Note: The tables above show regression results of changes in log-levels of the joint credit series pertaining to the non-tradable sector and industries belonging to an additional sector on the treatment variable $Post \cdot Spanish\ Share_{2011}$ in the presence of municipality and time fixed effects. Data from two periods are used - June 2012 and June 2013. The variable *Post* indicates June 2013 and the exposure to Spanish banks is measured by the municipality level share of Spanish banks in the household credit market in June 2011. The top table shows results for the full sample and the bottom table shows the results for the sub-sample of municipalities with very low exposure to Spanish banks for non-tradable firms.

Chapter 2

Relationship Lending and the Consequences of Shocks to Bank Capital

2.1 Introduction

Macroprudential regulations based on capital requirements are frequently cited by policy makers as an effective tool to ring fence the real economy from the effects of financial crises. Consequently, the study of the efficacy of capital requirements in enhancing the performance of banks and in ensuring access to credit to firms during times of crisis has generated a significant amount of interest among researchers. While the evidence on the efficacy of capital requirements in this regard has been positive[1], this chapter dresses an issue relatively understudied so far - the effect of capital requirements on the composition of a bank's lending portfolio. In particular, I document stylized facts from an episode of macroprudential regulations in Spain that led to a contraction in the supply of household credit by Spanish banks in Mexico without affecting loans to firms by the same banks.

I shared evidence in chapter 1 of a contraction in lending to households by the Mexican subsidiaries of two large Spanish banks in response to an increase in capital requirements initiated by the Spanish Government in early 2012. I showed that Mexican municipalities with a larger pre-shock share of Spanish banks in the household credit

[1] Faulkender and Petersen (2006) and Gambacorta and Mistrulli (2004) look at the effect of financial crises on banks and find that better capitalized banks are better equipped to tide through financial crises and more likely to maintain and expand their market shares during such episodes. Their result are stronger for small banks. Jimenez et al. (2012) study the efficacy of the counter-cyclical macroprudential regulations in Spain and find that firms with relationships with better capitalized banks are more immune to aggregate financial shocks.

market experienced a larger contraction in the growth rate of household credit. The same high exposure municipalities also experienced a contraction in lending to the non-tradable sector (primarily the retail sector). While I had argued in the earlier chapter that the contraction in the non-tradable sector could not have been the direct result of a supply shock from Spanish banks, I provide additional and more direct evidence in this chapter to support the singular observation that lending to Mexican firms by the Spanish banks was unaffected by the Spanish regulations.

Firstly, I show that the contraction in the non-tradable sector in high exposure Mexican municipalities is only explained by the share of Spanish banks in the household credit market and not by the share of Spanish banks in the corporate credit market. This could still indicate that the Spanish banks concentrated the negative shock to their credit supply to households and firms in the retail sector located in specific municipalities. In order to check whether this hypothesis is true, I breakdown the credit to the non-tradable sector at a municipality level into credit issued by Spanish and non-Spanish banks. If the contraction in lending to the non-tradable sector was also observed in lending by non-Spanish banks, it would validate the idea that the contraction in the non-tradable sector is driven by changes in local demand rather than a supply shock from Spanish banks. I find very strong evidence from a sub-sample of municipalities with limited exposure to Spanish banks in the non-tradable sector that the contraction in lending to non-tradable firms was also seen in lending by non-Spanish banks. However, the evidence on lending by non-Spanish banks in the full sample of municipalities yields inconclusive results.

I use firm-level microdata to check whether firms in a lending relationship with Spanish banks experienced a change in their loan contracts in the aftermath of the Spanish regulations. I use a specification analogous to Khwaja and Mian (2008) on a sample of firms with loan relationships with multiple banks to show that there was no change in the level and average interest rate of the marginal credit issued by Spanish banks to a firm *relative* to that extended by non-Spanish banks to the *same* firm in the periods after the introduction of the Spanish regulations.

The combined strength of the empirical results in the previous and the current chapter strongly suggests that changes in capital requirements have implications on the composition of a bank's credit portfolio. I propose a simple theoretical model in which proprietary information acquired by banks on different segments of their lending portfolio can account for heterogeneous effects of changes in capital requirements on these segments. I consider two types of projects - F and M-type projects. F-type projects include *good* projects which always yield output and *bad* projects which never yield output. M-projects on the other hand are all of the same type that yield output with

a commonly known probability of success. While banks fund F-type projects without any knowledge of the underlying project type, observing the output of their F-type borrowers allows them to intuit whether their borrowers are drawn from the set of *good* or *bad* projects. This signal on the underlying project type is proprietary to the lending (or insider) bank and not observed by any outsider bank. This allows insider banks to extract relationship rents from the *good* projects in future financing rounds since they (insider banks) only aim to meet the best outside funding option available to the borrower.

As has been shown in Engelbrecht-Wiggans et al. (1983), Sharpe (1990) and Rajan (1992), the model described above may not have equilibrium contracts in pure strategies by insider and outsider banks since such strategies entail a clear separation of types by contractual terms that are observable to all market participants. I introduce exogenous relationship termination between banks and borrowers to study an equilibrium solution in which interest rates do not reveal the borrowing type. The positive rents extracted from *good* projects in future financing rounds make *good* projects very valuable to an insider bank. There is no learning on the quality of a M-type project by a lending bank given the lack of any underlying uncertainty regarding their type and insider banks can not extract relationship rents from M-type projects. In the event of unanticipated shocks to banking capital in the second round of financing, banks rank-order projects in their portfolio based on expected rents and discontinue projects on which they do not hold any proprietary information.

Related Literature. To the best of my knowledge, the empirical evidence shared in this paper is unique in studying an event in which a change in capital requirements specifically affected lending to households. In addition, the corporate loans issued by the banks affected by the regulations are shown to be immune to any rebalancing efforts initiated by the banks. This is a significant departure from other contributions which, in assessing the efficacy of capital requirements as macroprudential instruments, have focused on bank-firm relationships. Such contributions (see Faulkender and Petersen (2006); Gambacorta and Mistrulli (2004) and Jimenez et al. (2012)) have generally presented a positive picture in the way capital requirements prevent bank failure and ensure continued access to credit by firms during times of financial crises. My results emphasize the need to consider the effects of changes in capital requirements on components of the credit portfolio other than corporate loans to minimize the potential for unintended consequences such as those resulting from shocks to household credit supply.

In the theoretical model, the fundamental difference between a borrowing relationship between a bank and a firm or a bank and a household is that a bank acquires propri-

etary information on the quality of a firm over the course of their lending relationship. There is no learning involved regarding the quality of borrowing households. The treatment of borrowing by firms as relationship based has a long tradition in theoretical and empirical financial literature. Broadly, banks may provide either screening services in an environment with asymmetric information (see Rajan (1992); Ramakrishnan and Thakor (1984); Allen (1990); Sharpe (1990)) or provide monitoring services in case moral hazard is a concern (for example Diamond (1984, 1991) and Winton (1995)). I abstract from the role of the banks as delegated monitors or as screening technologies. In my model banks simply issue contracts to firms and acquire information on the quality of the firm that can not be transmitted to other banks. In contrast to a bank-firm relationship, lending to households by banks is transactional in nature. The information set on which a household may be issued credit is common knowledge among the banks. This view is consistent with the idea that lending to households is based on hard information like income, credit history and FICO score which are publicly observed. Among recent contributions, De Haas et al. (2010), who show that foreign banks tend to specialize in mortgage lending, and Keys et al. (2010) and Keys et al. (2012), who show a negative impact of securitization on information acquisition while lending to households, have backed this view[2].

I present the results of this chapter in three sections. In section 2.2, I provide a brief summary of the afore-mentioned Spanish regulations and provide evidence to back the observation that the lending relationship between Mexican firms and Spanish banks were not affected by those regulations. In section 2.3, I present a theoretical model that shows why banks may prioritize lending relationships with firms over those with households in the event of a negative shock to bank capital. I conclude in section 2.4 with a discussion on future research on one of the crucial assumptions of the model - that banks do not acquire proprietary information on households over the course of their lending relationship.

2.2 Evidence on the effect of Spanish regulations

In February and May 2012, the newly elected Spanish Government introduced two regulations - Royal Decree Laws 02/2012 and 18/2012 - also known as '*Los Decretos de Guindos*' under the tutelage of Luis de Guindos Jurado, the Minister of Economy and

[2]Keys et al. (2010) show that securitization can lead to poorer performance of a portfolio of loans to households, suggesting that banks may also acquire soft information on households before issuing credit to them. This goes against the 'no proprietary information' assumption for loans to households used in this chapter. The specific case of loans to households in Mexico - whether transactional or relationship based - is currently, driven by data limitations, a matter of ongoing research.

Competitiveness of Spain. These twin laws were aimed to 'dissipate the uncertainty impeding the normalization of the financial sector'[3] and significantly increased the provision requirement for the real estate assets in the credit portfolio held by Spanish banks. The twin regulations imposed *general provisions* on the pre-existing Spanish real estate loans held by Spanish banks as of December 2011. The RDL 02/2012 imposed a loan-loss provision requirement of 7% on all real estate loans in the balance sheet of Spanish banks. RDL 18/2012 imposed additional requirements ranging from 7-45% on specific sub-groups of the real estate assets. These *general provisions* accounted for a sharp revision in the retained earnings reported by Spanish banks in mid-2012 and acted as the source of a credit supply shock for municipalities in Mexico exposed to Spanish banks[4],[5].

BBVA and Santander set aside additional capital to the tune of 4.5 and 6.5 billion euros respectively to meet the requirements of these regulations. These two banks, particularly BBVA, have a significant presence in the Mexican credit market. In the immediate aftermath of the introduction of the two regulations, there was a sharp decline in the growth rate of household credit issued by the Mexican subsidiaries of these banks. I also find that municipalities that had a larger exposure to Spanish banks experienced a larger slow down in the growth rate of household credit in the periods after the introduction of the regulations. In the next sub-section, I briefly describe the empirical strategy used to measure the shock to household credit supply at a municipality level and its impact on local economic activity.

2.2.1 Effect on lending to households and firms

I use a difference-in-difference specification to estimate the effect of the Spanish regulations on the growth rate of credit to households and firms at a municipality level. Based on the unexpected announcement of the regulations, I define a quasi-experiment

[3] http://noticias.juridicas.com/base_datos/Admin/rdl2-2012.html and http://noticias.juridicas.com/base_datos/Fiscal/rdl18-2012.html contain a detailed exposition on the conditions imposed by the regulations RDL 02/2012 and RDL 18/2012. In addition, ttp://nadaesgratis.es/santos/el-segundo-decreto-de-guindos-rdl-182012-de-11-de-mayo is a blog post by Tano Santos which includes a critical assessment of the two regulations.

[4] RDL 18/2012 stipulated that banks could meet the additional provision requirements by December 2012, even though they were directed to submit compliance reports by June 2012. Since most of the banks met the additional provisions through retained earnings, the banks absorbed any impact on their balance sheets arising from the regulations by mid-2012.

[5] *General provisions* are the key policy tools used to implement the counter-cyclical macroprudential policy followed by the Banco de España. These provisions are imposed on top of the *specific provisions* that the central bank obligates commercial banks to hold for any given credit line. While the ratios determining specific provisions are based on historical data on credit risk for a given credit type, *general provisions* are more discretionary.

in which treatment is measured by the exposure of a given municipality to Spanish banks. The treatment variable is given by an interaction term between the pre-shock share of Spanish banks in a given credit market in June 2011 ($Spanish\ Share_{j,2011}$) with a dummy which indicates periods after the introduction of Spanish regulations ($Post_t$). The regression specification is given by,

$$\Delta \log(h_{jt}) = \beta \cdot Post \cdot Spanish\ Share_{j,2011} + D_j + D_t + \varepsilon_{jt} \tag{2.1}$$

, where h_{jt} refers to household credit for municipality 'j' at time 't' and D_j and D_t are municipality and time dummies respectively. The coefficient β can be interpreted as the increase or drop in the growth rate of household credit that results from higher exposure to Spanish banks in periods after the introduction of the Spanish regulations.

I also check whether exposure to Spanish banks affected growth in credit to firms in different sectors of the economy. I do this using a regression specification similar to the one described above given by,

$$\Delta \log(c_{sjt}) = \beta_s \cdot Post \cdot \bar{Spanish}\ Share_{sj,2011} + D_j + D_t + \varepsilon_{jt} \tag{2.2}$$

, where c_{sjt} is the credit lent to sector 's' in municipality 'j' at time 't' and $Spanish\ Share_{sj,2011}$ is the share of Spanish banks in the credit market for sector 's' in municipality 'j' in June 2011. D_j and D_t are municipality and time fixed effects respectively. The coefficient β_s can be interpreted as the increase or drop in the growth rate of credit to firms in sector 's' that results from higher exposure to Spanish banks in periods after the introduction of the Spanish regulations. Finally, I report results for the full set of 999 municipalities in my sample and for a sub-sample of 379 municipalities with a limited exposure to Spanish banks in the credit market for firms in the non-tradable sector.

Table 2.1 shows that the share of Spanish banks in the household credit market is a highly significant predictor of the growth rate of household credit in periods after the introduction of the Spanish regulations. Municipalities with a higher exposure to Spanish banks experienced a larger decline in the growth rate of household credit, with a 10% higher share of Spanish banks predicting a 2.7% decline in the growth rate of household credit after the introduction of Spanish regulations (column 1).This drop in the growth rate of household can be seen in the decline in the growth rates of both housing credit and consumer credit (columns 2 and 3 respectively). In the previous chapter, I validated the difference-in-difference set-up by showing parallel trends in the growth rate of household credit between high and low exposure municipalities and by conducting placebo tests over periods before the introduction of the regulations.

In table 2.2, I regress municipality level growth rates in credit issued to different sectors

on a treatment variable based on the share of Spanish banks in the credit market for the same sector in June 2011. Results in table 2.2 show that exposure to Spanish banks does not explain changes in growth rates of credit issued to different sectors the way it does the growth in household credit in periods after the introduction of Spanish regulations. Table 2.3 qualifies the above result by regressing growth rates in credit issued to different sectors on a treatment variable based on the share of Spanish banks in the household credit market in June 2011 (the same treatment variable as in table 2.1). The results in table 2.3 indicate a contraction only in credit issued to the non-tradable sector in municipalities with a large presence of Spanish banks in the household credit market. The credit lending to other sectors of the economy was unaffected in these high exposure municipalities.

In the next sub-section I test whether the contraction in the non-tradable sector in high exposure municipalities shown in column 2 of table 2.3 could be the result of a direct supply shock from Spanish banks.

2.2.2 Tests on the contraction in the non-tradable sector

In table 2.3 (column 2), I reported a contraction in lending to the non-tradable sector in Mexican municipalities with a high exposure to Spanish banks in the household credit market. These same municipalities also experienced a negative shock to the supply of household credit in the aftermath of the financial regulations in Spain. In this sub-section I address the concern that the contraction in credit to the non-tradable sector in high exposure municipalities may also be the result of supply shocks from Spanish banks and not necessarily an outcome of a change in local demand driven by the decline in lending to households. Firstly, I test whether the contraction in lending to the non-tradable sector was observed in lending by both Spanish and non-Spanish banks. If true, it would strongly suggest that local demand effects and not supply shocks are the likely drivers of the contraction in the non-tradable sector in high exposure municipalities. Secondly, I use bank-firm level loan data (a la Khwaja and Mian (2008)) to test whether firms with lending relationships with multiple banks experienced a change in the lending contracts offered by Spanish banks after the introduction of Spanish regulations.

For the first test, I disaggregate the credit to the non-tradable sector at a municipality level used in table 2.3 into credit issued by Spanish and non-Spanish banks. I test whether the contraction in lending to the non-tradable sector captured by the treatment variable ($Post \cdot Spanish\ Share_{j,2011}$) can be seen in lending by both Spanish and non-Spanish banks and report results in table 2.4. The results from the sub-sample of municipalities (table 2.4 *b*) with a limited exposure to Spanish banks strongly sug-

gest that the contraction to the non-tradable sector resulted from lending by both Spanish and non-Spanish banks and is unlikely to be driven by a direct supply shock from Spanish banks. The result from the full sample of municipalities yields insignificant coefficients for the regressions involving credit issued by Spanish and non-Spanish banks and do not allow for making a distinction between the two.

I also use bank-firm level data to test whether lending relationship between firms and Spanish banks were distinct to that between firms and non-Spanish banks in Mexico in the aftermath of the regulations. In order to do so, I conduct a test similar to Khwaja and Mian (2008) by studying changes in loan conditions (in levels and contractual terms) for newly issued credit in December 2012 against the conditions in December 2011 for a sub-sample of firms with loan relationships with multiple banks. This helps us to test whether there was a significant change in the loan conditions offered by specific banks while controlling for firm specific factors (for e.g. changes in demand for credit) through firm fixed effects.

The actual regression specification is given by,

$$\Delta log(c)_{jb} = \beta_0 + \beta_1 \cdot (Dummy = Spanish) + f_j + \epsilon_{jb} \tag{2.3}$$

, where $\Delta log(c)_{jb}$ refers to the change in marginal credit (in levels or average interest rate) issued to firm 'j' by bank 'b' between December 2011 and December 2012, *Dummy* identifies marginal credit issued by Spanish banks[6] and f_j refers to firm fixed effects. As described in the above equation, I regresses changes in the level and average interest rate of marginal credit issued during December 2011 and December 2012 (6 months before and after the introduction of regulations respectively) on firm-fixed effects and a bank dummy. The coefficient of the bank dummy shows how the loan conditions to the firm have changed from the bank represented by the dummy *relative* to other banks[7], while the firm fixed effects control for factors that affect the firm's lending relationships with all banks equally, most notably demand for credit by the specific firm.

[6]There are two Spanish banks operational in Mexico. I also test for alternative specification in which the *Dummy* represents one of these two banks to check if firms with lending relationships with one of these two banks might have been affected.

[7]The coefficient on the bank dummy can also be interpreted as the effect on the loan conditions resulting from any shocks suffered by the bank represented by the dummy. In Khwaja and Mian (2008), the authors use changes in liquidity available to a bank (instead of a bank dummy) to draw a causal link between large negative shocks to funding available to banks and the amount of loans offered by them to firms. Given the lack of a direct measure for the effect of the Spanish regulations on specific banks, I use a Spanish bank dummy to test whether the loan contracts for marginal credit issued by Spanish banks to a given firm changed in a manner distinct from those offered by non-Spanish banks.

I use bank-firm level data on the level and average interest rate of marginal credit issued during December 2011 and December 2012 from the Mexican credit registry to present results based on specification 2.3. Since I control for any changes in firm demand through firm fixed effects, I only consider firms that received marginal credit from at least two banks during the periods mentioned above. In addition to reporting regression results based on the full sample of bank-firm relationships, I also report results based on a sub-sample of bank-firm relationships by only including firms from the non-tradable sector. I report the regression results for changes in loans in table 2.5 and for changes in average interest rate in table 2.6.

The reported results are based on 1,193 firms that were issued marginal credit in both December 2011 and December 2012 by more than one bank. Out of these, 152 firms belonged to the non-tradable sector. I report results for both the full sample and the sub-sample containing only non-tradable firms. In table 2.5, I find that there is no relative difference in change in the loan level issued to firms between Spanish and non-Spanish banks since the coefficient of the dummy identifying Spanish banks in the regression are small and insignificant. The results do not change if I restrict the bank dummy to identify either of the two Spanish banks operational in Mexico, BBVA and Santander (column (3) onwards). The picture presented by the regressions based on changes in the average interest rate of marginal credit (table 2.6) also suggest that there was no different in the loan contracts offered by Spanish banks relative to non-Spanish banks.

The evidence shared in this section strongly suggests that loan conditions to Mexican firms by Spanish banks were immune to the negative shock to the supply of credit resulting from the Spanish regulations. In the next section I explore a simple theoretical model in which proprietary information held by banks on specific projects enable them to seek positive rents while funding such projects. These rents can lead to the prioritization of such relationships in the event that the bank is forced to rebalance their credit portfolio by discontinuing some relationships.

2.3 Asymmetric information and rents for insider banks

I write a simple theoretical model to elucidate the difference between a pre-existing relation with firms and households for a bank. The key assumption is that banks do not acquire any proprietary information on households to which they issue credit in the form of mortgages or consumer credit, where as they (banks) do so for firms and

entrepreneurs over the course of their lending relationship. I use a simplified version of the framework in Sharpe (1990) to study the bank's funding choice in the presence of a shock to its bank capital. I use the model to provide a very clear intuition as to how the positive rents captured based on proprietary information can account for banks ranking loans to firms ahead of direct loans to households in the event of a negative shock to bank capital.

2.3.1 Projects and banks

Projects. I model an economy that lasts for three periods $t = 0, 1, 2$. Economic activity takes place in projects which operate in the duration intervening the periods and yield output at $t = 1, 2$ and require an investment of I units at the beginning of each round of production. Each of these projects is denoted by $f \epsilon [0, 1]$ and must seek financing by banks at the financing rounds in $t = 0, 1$. I call these units F-type projects. In the first round of financing at $t = 0$, while the project type is unknown to either the project-owner or the banks, a proportion θ of the projects is known to belong to good-types that yield output with probability 1 whenever funded. The other projects, of measure $1 - \theta$ do not yield any output. Banks can observe the output of the projects funded by them and hence receive a perfect signal on the type of project (whether good or bad) funded by them. This information is assumed to be intransferable to other banks.

In the second round of funding, project owners have the option of continuing with their current bank or accept a credit contract from an outsider bank. The former, the insider bank, has information on the project quality where as the latter type of bank does not. In this simple scenario, the insider banks will not fund any of the bad projects in their portfolio in the second period and continue funding the good projects. The outsider banks will know that any projects they manage to lure away from a competing bank must be a bad project and hence will not make any offers in the second round of financing. As has been shown in von Thadden (2004) and Engelbrecht-Wiggans et al. (1983), such a solution in pure strategies can not exist when the pure strategies lead to a separation of types between the insider and outsider banks. In such an equilibrium in pure strategies, the insider banks are in a position to exact rents from the good projects and outsider banks can follow a mixing strategy to attack some of those rents and lure *some* good projects away from their existing relationship.

To further simplify the resulting equilibrium, I assume that a bank-project relationships undergo termination at an exogenous rate β<1. This termination of the bank-project relationship is not driven by a counter-offer from an outsider bank but can

be driven by either incompatibility between the bank and the project-owner or any other reason that makes the current relationship untenable (potential reasons can be a change in management at the bank or the project, restructuring or relocation decision by the project owner etc.). This simple assumption helps rule out separating equilibria in which interest rates can reveal the borrower type**.**

In addition to the projects described above, there are countably inexhaustible projects of type M which succeed with a probability p_M. Similar to F-type project, banks must provide funds to the M-type projects in both the financing rounds for the projects to be operational. The success probability p_M is known to all the banks and banks do not acquire any proprietary information related to a M-type project after the first period of operations. Therefore, the offer by an outsider bank will be as good as that offered by any insider bank in both rounds of financing.

Banks. The economy has banks which operate under perfect competition and make competitive contract rates to the project owners. For each unit of credit, regulations stipulate a capital requirement of κ units of capital. As a result, the total amount of credit issued by banks is capped by $\frac{K}{\kappa}$, where K is the total capital base of all the banks in the economy. For a given κ, each unit of credit must be financed with κ units of capital and $1-\kappa$ units of other liabilities. Assuming that capital is more expensive than other forms of liabilities (deposits or bonds), I consider an exogenous cost of financing $\bar{r}$ to the bank [8]. I also assume that $\frac{K}{\kappa} > 1$, i.e. there is enough capital in the financial system to fund all the F-type projects in the economy. In the next section, we look at the banks choice to fund a project given its information about the project type and its funding cost $\bar{r}$.

In the first round of financing, no bank has information regarding the underlying type of the F-type projects. Therefore, all projects drawn from $f \epsilon [0,1]$ are offered the same contract R_1. After the first period of operation, all the F-type projects are up for refinancing and the equilibrium contract rates are given by $R_{2i}(\gamma)$ and R_{2o} where $R_{2i}(\gamma)$ is the contract offered by an insider bank i in the second round of financing for the observed signal $\gamma \subset \{G, B\}$; $R_{2O}$is the contract offered by the outsider bank which must issue a contract unconditioned by any project specific information. The banks can observe the contractual rates posted by each other, but not the project types they are issued to. Hence an equilibrium in pure strategy can exist provided the equilibrium rates do not divulge the project-type they are issued to. The project owners can go from insider banks to outsider banks, comparing counter-offers, an infinite number of

[8] This is similar to the exogenous cost of financing in Sharpe (1990). In this paper I motivate the cost $\bar{r}$ to bank for each unit of credit to be a result of the capital requirements imposed on the banks and the liability structure stipulated by the same.

times in a very short period of time. They can perfectly communicate the contractual rates offered by one bank to the other, but are incapable of sharing any information on their underlying type to the outsider banks.

2.3.2 Equilibrium Contracts

In the model described above, any action taken by the firm in the second round of financing can not affect outcomes and hence a given bank and a project owner can ex-ante write long-term state contingent contracts that mimic short-term contracts where the contractual rates are agreed upon in each round of financing. All the possible states a project owner can find herself in the second period are perfectly known and a long-term contract can make provisions for all possible outcomes without the risk of non-compliance by the bank or the project owner. In the given section I present an equilibrium with short term contracts and argue that the same equilibrium can also be generated by state-contingent long-term contracts. First I consider the contracts offered by insider and outsider banks in the second round of financing to quantify ex-ante expected rents from a relationship. Given perfect competition between banks in the model, these rents are competed away in the equilibrium contracts offered in the first round.

Second round of financing. Insider banks receive a perfect signal on the quality of the project funded by them by the observed output. The *good* projects succeed with probability 1 where as the *bad* projects do not succeed at all. The zero profit contract rate that would be offered by an inside bank to a good project it has a relationship with is therefore $1+\bar{r}$. The insider banks offer these *good* projects a contract $R_{2i}(G)$. Any project revealed to belong to the $1-\theta$ measure of bad firms is not funded by insider banks.

Any offer put forth by an outsider bank will be picked up by *good* projects that are in the market for new financiers and by *bad* projects that are willing to borrow at any interest rate. Conditional on its offer being accepted by the *good* projects, the zero profit interest rate for an outside bank is given by $(1+r_{2o})\cdot(\frac{\beta\theta}{\beta\theta+1-\theta}) = (1+\bar{r}) \Rightarrow r_{2o} = \frac{(1+\bar{r})\cdot(\beta\theta+1-\theta)}{\beta\theta} - 1$. Given the possibility of its offer being accepted by both *good* and *bad* projects, any contractual rate R_{2o} offered by the outsider bank must be atleast $1+r_{2o}$.

Lemma 1 : Outsider banks offer $r_{2o} = \frac{(1+\bar{r})\cdot(\beta\theta+1-\theta)}{\beta\theta} - 1$ to any projects that seek funding from them. These projects include a mix of *good* projects with a severed relationship with their original bank and *bad* projects that manage to seek funding because of the inability of project owners to signal their true type. Insider banks

discontinue all *bad* projects and fund *good* projects at a higher interest rate than the zero-profit rates of $\frac{1+\bar{r}}{\theta} - 1$. The insider banks charge *good* projects $R_{2i}(G) = R_{2o}$ and make a profit of $(1+\bar{r}) \cdot \frac{1-\beta\cdot}{\beta} \cdot \frac{1-\theta}{\theta}$ per project. Thus, the equilibrium contract rates offered by the insider and outsider banks do not reveal the quality of the borrower.

Lemma 1 is similar to the equilibrium concept used in Sharpe (1990) even though, in the current model, the contractual terms offered in future financing rounds do not reveal the borrower type. The equilibrium solution is still open to the criticism in von Thadden (2004) regarding Nash equilibria in mixed strategies being the correct candidate solution for equilibrium during the second round of financing. Rather than solve for the mixed strategies equilibrium, I focus on pure strategies of the type presented in Sharpe (1990) since the aim here is to highlight the role of proprietary information held by insider banks as the source of the relationship rents extracted by them. Besides, the equilibria in mixed strategies only limit the amount of relationship rents extracted by insider banks rather than ruling out relationship rents altogether. The relationship rent presented in Lemma 1 is the upper bound of the rents that can be extracted by an insider bank in the second round of financing.

First round of financing. Both banks and project owners are unaware of the underlying project type in the first period. The first period of production leads to both the bank and the project owner learning the quality of the project and the banks can ex-ante expect to make a positive profit from refinancing good projects in the second round. These expected profits are competed away and the banks finance all the projects at a contractual rate lower than the zero-profit rate of being randomly matched with a firm from the distribution $f \epsilon [0, 1]$.

Lemma 2: Conditional on being matched with a good project, the bank can make positive profits of $\frac{(1+\bar{r})\cdot(1-\theta)}{\beta\theta}$ per project. The contracted rate r_1 under perfect competition is given by the zero profit condition $\theta \cdot (1 + r_1 + (1+\bar{r}) \cdot \frac{1-\beta\cdot}{\beta} \cdot \frac{1-\theta}{\theta}) = (1+\bar{r})$, i.e. $r_1 = (1+\bar{r}) \cdot \{\frac{1}{\theta} - \frac{1-\beta\cdot}{\beta} \cdot \frac{1-\theta}{\theta}\} - 1 < \frac{(1+\bar{r})}{\theta} - 1$, where $\frac{1+\bar{r}}{\theta} - 1$ would have been the contractual rate without the possibility of seeking rents from *good* projects in the second round of financing.

In the equilibrium described above, the insider banks continue to fund the *good* projects at a rate which makes the later just indifferent to the best possible contractual rate offered by outsider banks. Even if outsider banks observe the rates offered by the insider banks, they offer a contractual rate which can be accepted by both *good* and *bad* projects in the credit market for different reasons. Since the rates offered by the insider and outsider banks are the same, the rates do not reveal the true nature of the underlying projects as in the pure strategy solutions to Sharpe (1990).

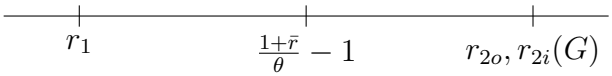


Figure 2.1: Contractual Rates

As we see in figure 2.1, for a given cost of funds $\bar{r}$, the second period contractual rates offered by inside banks to *good* projects, $r_{2i}(G)$, is always higher than the cost of funding. The positive rents $r_{2i}(G) - \bar{r}$ made by the inside banks are a decreasing function of β, that is higher the probability of exogenous termination, lower are the rents that can be made by the inside banks. Consequently, the interest rate charged in the first period is an increasing function of β since if β lowers the positive rents made in the second round of financing, the rents that are competed away in the first period are lower and r_1 edges closer to the zero rent cost of financing $\frac{1+\bar{r}}{\theta} - 1$. In the extreme case of $\beta = 1$, the inside banks can not extract rents any more and the contract rate offered in the first period attains the highest possible value of $r_1 = \frac{1+\bar{r}}{\theta} - 1$. In fact, at $\beta = 1$, $r_1 = r_{2o} = r_{2i}(G)$. For any other $\beta < 1$, $r_1 < \frac{1+\bar{r}}{\theta} - 1 < r_{2o}, r_{2i}(G)$.

2.3.3 Effect of shocks to bank capital

Any unanticipated shock to bank capital in the second round of financing will lead to banks either expanding their loan portfolio in the event of a positive shock or discontinuing pre-existing relationships in the event of a negative shock. This results from the assumption that the credit supply is determined by the amount of capital held by the banks and the capital requirement imposed by regulations. As described earlier, the capital requirements affect the leverage on the amount of capital held by banks and hence any shock to capital requirements or the level of bank's capital base affects the credit supply. For example, if the amount of bank capital changes from K to $K^{'}$, the change in credit supply is given by $(K' - K)/\kappa$. A change in bank capital requirements from κ to κ' changes the credit supply by $K/\kappa' - K/\kappa$. The Proposition 1 summarizes the key insight of the paper - in the event of a negative shock to bank credit supply, banks prioritize all the *good* F-type projects since they stand to make positive rents on these projects.

Proposition 1: In the second round of financing, banks make positive rents on any relationship with *good* projects and terminate all relationships with bad projects. The M-type projects are financed at cost and the expected profits from these projects are zero. In the event of an unanticipated negative shock to capital, all inside banks prioritize the continuation of relationships with *good* projects. Negative shocks to

bank capital are absorbed by, to begin with, contracting loans to the M-type projects or loans made to F-type projects as outside banks.

Proof. The proposition directly follows from the positive rents made on successful projects in the second round of financing as discussed in Lemma 1.

A direct implication of proposition 1 is that successful F-type projects are prioritized notwithstanding the source of the shock to bank capital. For example, an increase in the capital requirements for the F-type projects will also lead to a downward readjustment in the bank's credit portfolio. While footing higher capital requirements might increase the cost of refinancing *good* F-type projects and reduce the rents extracted from the relationship, this projects would still be preferred to funding projects as an outside bank. The above result is encapsulated in Lemma 3.

Lemma 3: The results in Proposition 1 are independent of any shocks to asset specific capital requirements. Shocks to capital requirements are reflected in the asset specific cost of financing $\bar{r}_s$ and while such shocks can affect the amount of rents captured from *good* projects, the priority of funding projects in the second round of financing remains unchanged.

The current model is consistent with the two complementary views regarding the effect of the Spanish regulations on lending to households in Mexico. The international transmission might have taken place as a negative shock to the capital base of the Mexican subsidiaries of Spanish banks given the capital burden imposed on the parent company. Secondly, the Mexican subsidiaries might have themselves adopted higher capital requirements on mortgages mimicking the behaviour of their headquarters in Spain. While I do not share evidence on the strength of the two channels, we can not rule out the first channel since I document a decline in the growth rate of lending to consumer credit even though the Spanish regulations were strictly aimed at Spanish mortgages.

2.4 Conclusion

The theoretical model shared in this chapter predicts that in the event of a shock to a bank's capital base, the adjustment in the credit portfolio is largely felt on lending relationships in which the bank does not hold proprietary information on the underlying quality of the borrower. I use this idea to explain the contraction in lending to Mexican households by Spanish banks. The argument presented in this paper, therefore, crucially hinges on the idea that lending to households in Mexico is transactional, i.e., banks do not acquire any information through repeated interactions with households.

The empirical literature assessing the strength of bank-borrower relationships has so far focused on bank-firm relationships. Berger and Udell (1995); Berger et al. (2005); Petersen and Rajan (1995) have studied the way lending relationships are established by small or large banks (their results show that small banks are more likely to rely on soft information) and Petersen and Rajan (2002) have studied the differences in lending relationships established by domestic and foreign banks (they show that foreign banks tend to be more transactional). The lending relationship between banks and households has yet to receive such a systematic attention even though the idea that lending relationships between banks and households are more transactional is not new. Given that information held by banks is likely to be an important determinant of bank behaviour in response to capital requirements, this assertion merits greater attention by researchers interested in the empirical assessment of the nature of financial intermediation.

Table 2.1: Effect of Spanish regulations on household credit lending in Mexico

(a) Regressions based on the full sample

VARIABLES	(1) Δ log (Household Credit)	(2) Δ log (Housing Credit)	(3) Δ log (Consumer Credit)
Post*Spanish Share$_{2011}$	-0.267***	-0.258***	-0.209***
	(0.0370)	(0.0712)	(0.0436)
Observations	1,998	1,908	1,998
Number of municipalities	999	960	999
R-squared	0.684	0.660	0.624
Mun. Fixed-effects	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

(b) Regressions based on the sub-sample with low share of Spanish banks in the non-tradable credit market

VARIABLES	(1) Δ log (Household Credit)	(2) Δ log (Housing Credit)	(3) Δ log (Consumer Credit)
Post*Spanish Share$_{2011}$	-0.228***	-0.423***	-0.120*
	(0.0605)	(0.124)	(0.0620)
Observations	758	701	758
Number of municipalities	379	354	379
R-squared	0.626	0.594	0.624
Mun. Fixed-effects	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

Note: The tables above show regression results of changes in log-levels of credit to households on the treatment variable $Post \cdot Spanish\ Share_{2011}$ in the presence of municipality and time fixed effects. Data from two periods are used - June 2012 and June 2013. The variable *Post* indicates June 2013 and the exposure to Spanish banks is measured by the municipality level share of Spanish banks in the household credit market in June 2011, almost an year prior to the introduction of the Spanish regulations. The top table shows results for the full sample and the bottom table shows the results for the sub-sample of municipalities with very low exposure to Spanish banks for non-tradable firms. The municipality fixed effect controls for any municipality level trends and the coefficient of the treatment variable indicates a drop in the growth of household credit in municipalities with a high Spanish share.

Table 2.2: Effect of exposure to Spanish banks at a municipality level

(a) Regressions based on the full sample

VARIABLES	(1) Δ log (Corp. Credit)	(2) Δ log (Non-trad.)	(3) Δ log (Non-trad. + Const.)	(4) Δ log (Tradable)
Post*Spanish Share in Corp. Credit	-0.0728	-0.00213	0.0483	-0.183
	(0.117)	(0.157)	(0.148)	(0.315)
Observations	1,996	1,998	1,998	1,413
Number of municipalities	998	999	999	739
R-squared	0.459	0.429	0.444	0.407
Mun. Fixed-effects	Yes	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

(b) Regressions based on the sub-sample with low share of Spanish banks in the non-tradable credit market

VARIABLES	(1) Δ log (Corp. Credit)	(2) Δ log (Non-trad.)	(3) Δ log (Non-trad. + Const.)	(4) Δ log (Tradable)
Post*Spanish Share in Corp. Credit	0.215	0.153	0.502	-0.561
	(0.228)	(0.317)	(0.334)	(0.538)
Observations	758	758	758	394
Number of municipalities	379	379	379	216
R-squared	0.432	0.414	0.409	0.370
Mun. Fixed-effects	Yes	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

Note: The tables above show regression results of changes in log-levels of credit to firms on the treatment variable $Post \cdot Spanish\ Share\ Corp_{2011}$ in the presence of municipality and time fixed effects. Data from two periods are used - June 2012 and June 2013. The variable *Post* indicates June 2013 and the exposure to Spanish banks is measured by the municipality level *share of Spanish banks in the corporate credit markets*. The top table shows results for the full sample and the bottom table shows the results for the sub-sample of municipalities with very low exposure to Spanish banks for non-tradable firms.

Table 2.3: Effect of exposure to Spanish banks at a municipality level - II

(a) Regressions based on the full sample

VARIABLES	(1) Δ log (Corp. Credit)	(2) Δ log (Non-trad.)	(3) Δ log (Non-trad. + Const.)	(4) Δ log (Tradable)
Post*Spanish Share	0.0507	-0.440**	-0.287*	-0.394
	(0.160)	(0.186)	(0.173)	(0.363)
Observations	1,996	1,998	1,998	1,413
Number of municipalities	998	999	999	739
R-squared	0.459	0.432	0.445	0.408
Mun. Fixed-effects	Yes	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

(b) Regressions based on the sub-sample with low share of Spanish banks in the non-tradable credit market

VARIABLES	(1) Δ log (Corp. Credit)	(2) Δ log (Non-trad.)	(3) Δ log (Non-trad. + Const.)	(4) Δ log (Tradable)
Post*Spanish Share	-0.0911	-0.797**	-0.470	-1.101
	(0.280)	(0.321)	(0.305)	(0.700)
Observations	758	758	758	394
Number of municipalities	379	379	379	216
R-squared	0.431	0.422	0.407	0.373
Mun. Fixed-effects	Yes	Yes	Yes	Yes
Time Fixed-effects	Yes	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

Note: The tables above show regression results of changes in log-levels of credit to firms on the treatment variable $Post \cdot Spanish\ Share_{2011}$ in the presence of municipality and time fixed effects. Data from two periods are used - June 2012 and June 2013. The variable *Post* indicates June 2013 and the exposure to Spanish banks is measured by the municipality level share of Spanish banks in the household credit market in June 2011. The top table shows results for the full sample and the bottom table shows the results for the sub-sample of municipalities with very low exposure to Spanish banks for non-tradable firms.

Table 2.4: Contraction in lending to the non-tradable sector by Spanish and non-Spanish banks

(a) Regressions based on the full sample

VARIABLES	(1)	(2)	(3)
	Δ log (Non-Tradable)		
	Total	Spanish	Non-Spanish
Post*Spanish Share$_{2011}$	-0.344*	-0.320	0.0622
	(0.184)	(0.305)	(0.316)
Observations	1,222	1,222	1,222
R-squared	0.526	0.498	0.463
Number of municipalities	656	656	656
Time Fixed-Effects	Yes	Yes	Yes
Municipality Fixed-Effects	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

(b) Regressions based on the sub-sample with low share of Spanish banks in the non-tradable credit market

VARIABLES	(1)	(2)	(3)
	Δ log (Non-Tradable)		
	Total	Spanish	Non-Spanish
Post*Spanish Share$_{2011}$	-1.174**	-1.864*	-1.240**
	(0.562)	(1.027)	(0.576)
Observations	201	201	201
R-squared	0.625	0.571	0.643
Number of municipalities	132	132	132
Time Fixed-Effects	Yes	Yes	Yes
Municipality Fixed-Effects	Yes	Yes	Yes

Clustered standard errors at a municipality level
*** p<0.01, ** p<0.05, * p<0.1

Note: The tables above show regression results of changes in log-levels of credit to firms in the non-tradable sector on the treatment variable $Post \cdot Spanish\ Share\ Corp_{2011}$ in the presence of municipality and time fixed effects. Data from two periods are used - June 2012 and June 2013. The credit at a municipality level is further disaggregated into credit issued by Spanish and non-Spanish banks to test whether the contraction in the non-tradable sector observed in the high exposure municipalities was not the direct result of a supply shock from Spanish banks. The results from the restricted sample of municipalities (table *b*) strongly suggests that the contraction reported in the non-tradable sector can be seen in the credit issued by both Spanish and non-Spanish banks.

Table 2.5: Firm level evidence on change in lending at a bank-firm level from Dec 2011 to Dec 2012

(a) All Firms

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Δ log (Loans)	Δ log (Loans)	Δ log (Loans)	Δ log (Loans)	Δ log (Loans)	Δ log (Loans)
Dummy = Spanish	0.0710	0.0544				
	(0.0577)	(0.0706)				
Dummy = Bank 1			0.124**	0.0878		
			(0.0608)	(0.0784)		
Dummy = Bank 2					-0.0306	-0.0199
					(0.0980)	(0.111)
Observations	2,569	2,569	2,569	2,569	2,569	2,569
R-squared	0.001	0.504	0.001	0.504	0.000	0.504
Number of firms	-	1,193	-	1,193	-	1,193
Firm FE		Yes		Yes		Yes

Clustered standard errors at a firm level
*** p<0.01, ** p<0.05, * p<0.1

(b) Only Non-tradable Firms

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Δ log (Loans)	Δ log (Loans)	Δ log (Loans)	Δ log (Loans)	Δ log (Loans)	Δ log (Loans)
Dummy = Spanish	0.0737	-0.0880				
	(0.175)	(0.188)				
Dummy = Bank 1			0.263	0.00721		
			(0.187)	(0.227)		
Dummy = Bank2					-0.250	-0.215
					(0.287)	(0.353)
Observations	322	322	322	322	322	322
R-squared	0.000	0.566	0.004	0.565	0.003	0.566
Number of firms		152		152		152
Firm FE		Yes		Yes		Yes

Clustered standard errors at a firm level
*** p<0.01, ** p<0.05, * p<0.1

The above table regresses changes in level of marginal loans at a bank-firm level in the presence of firm fixed effects. The coefficient on the bank dummy suggests whether lending relationships with a particular bank suffered over the period December 2011 to December 2012. The fixed effect controls for any firm specific shocks that are common across all the banks, for example, firm specific demand for credit. The results suggest that there was no difference in the changes in the level of marginal credit issued to a firm by Spanish banks relative to that issued by non-Spanish banks over the period. Marginal credit refers to the newly issued credit in the three months preceding the date under consideration.

Table 2.6: Firm level evidence on change in average interest rates at a bank-firm level from Dec 2011 to Dec 2012

(a) All Firms

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Δ (Int. Rate)	Δ (Int. Rate)	Δ (Int. Rate)	Δ (Int. Rate)	Δ (Int. Rate)	Δ (Int. Rate)
Dummy = Spanish	0.0390	-0.0391				
	(0.0867)	(0.104)				
Dummy = Bank 1			0.170*	0.118		
			(0.103)	(0.118)		
Dummy = Bank 2					-0.153	-0.234*
					(0.119)	(0.140)
Observations	2,570	2,570	2,570	2,570	2,570	2,570
R-squared	0.000	0.478	0.001	0.478	0.001	0.479
Number of firms	-	1,194	-	1,194	-	1,194
Firm FE		Yes		Yes		Yes

Clustered standard errors at a firm level
*** p<0.01, ** p<0.05, * p<0.1

(b) Only Non-tradable Firms

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Δ (Int. Rate)	Δ (Int. Rate)	Δ (Int. Rate)	Δ (Int. Rate)	Δ (Int. Rate)	Δ (Int. Rate)
Dummy = Spanish	-0.0158	-0.0865				
	(0.233)	(0.278)				
Dummy = Bank 1			0.300	0.471		
			(0.211)	(0.291)		
Dummy = Bank 2					-0.497	-0.997*
					(0.478)	(0.542)
Observations	322	322	322	322	322	322
R-squared	0.000	0.478	0.004	0.485	0.008	0.497
Number of firms		152		152		152
Firm FE		Yes		Yes		Yes

Clustered standard errors at a firm level
*** p<0.01, ** p<0.05, * p<0.1

The above table regresses changes in average interest rate of marginal credit at a bank-firm level in the presence of firm fixed effects. The coefficient on the bank dummy suggests whether the change in average interest rate of marginal credit was different for Spanish banks with respect to the non-Spanish banks over the period December 2011 to December 2012. The fixed effect controls for any firm specific shocks that are common across all the banks, for example, firm specific shocks to demand for credit. The results suggest that there was no difference in the changes in the cost of marginal credit issued to a firm by Spanish and non-Spanish banks over the period. Marginal credit refers to the newly issued credit in the three months preceding the date under consideration.

Chapter 3

Bubbly Equilibria with Credit Misallocation

3.1 Introduction

There has been a surge in academic interest on asset bubbles since the last financial crisis. Many of these papers have focused on the role of financial constraints in the existence of bubbles (for example Farhi and Tirole (2011) and Martin and Ventura (2012)). In this paper, I explore how crowding-out of investments in the presence of bubbles may affect the composition of investments as well. In direct contrast to Martin and Ventura (2012), the results of my paper highlight a scenario in which asset bubbles lower the productivity of investments in an economy.

I study the impact of asset bubbles on economic growth in an economy with financial constraints and heterogeneous projects. Financial constraints are measured by the pledgeability of a project's output in financial markets. The economy has two sectors that absorb the net wealth of the economy every period. The economy has a traditional sector with low levels of productivity and, by virtue of being perceived as a stable, mature industry, low levels of financial constraints. There is also a modern sector which despite having a higher level of productivity faces a higher financial constraint. Economic growth in this economy takes place in two phases. At low levels of income (or wealth, the two are the same in the model), a large fraction of the financial resources are intermediated to the traditional sector since interest rates are high and the borrowing constraints bind tightly for the more financially constrained modern sector. As wealth increases and interest rates decline, the borrowing constraints of the modern sector are relaxed since projects need to borrow lower amounts from the credit markets. Thus at high levels of wealth, financial resources are allocated to the two sectors in the order

of their productivity and the economy experiences a sharp pickup in growth rates driven by increases in investment productivity when a larger fraction of resources are allocated to the modern sector.

In this economy, an increase in financial constraints lowers equilibrium interest rates and creates conditions for the existence of asset bubbles. Asset bubbles can hinder the process of transition to the high investment productivity state through the crowding-out of investments which increases interest rates and lowers wealth creation. The increase in interest rates and the lower wealth in the presence of asset bubbles tightens the borrowing constraint for the financially constrained modern sector. Therefore, asset bubbles hinder the transition to the higher investment productivity state and may even completely rule them out. I show the existence of steady states in the presence of bubbles in which crowding-out of investments ensures that the economy does not acquire the wealth necessary to transition to the higher productivity phase, which it otherwise would have in the absence of the higher interest rates engendered by the asset bubbles. In the bubbly steady state, the economy experiences a lower investment productivity and a lower average consumption as compared to the fundamental steady state. Such steady states in the presence of bubbles act as *growth traps*.

I call the asset bubbles that condemn the economy to lower investment productivity and lower average consumption as misallocative bubbles. The two main ingredients that deliver the results of my paper are the lumpy project size (I assume that each project requires an initial investment of 1 unit of final good a la Matsuyama (2007)) and the higher levels of financial constraints in the modern sector. Together these assumptions deliver the two phases of economic growth in the model. The modern sector is priced out of the credit market at low income levels when interest rates are high. The modern sector muscles ahead of the lower productivity traditional sector at high income levels when the interest rates are lower and the borrowing constraints less binding. The misallocative bubbles may exist either because the investments by the traditional sector are dynamically inefficient at steady state or because the traditional sector is itself financially constrained to the extent that asset bubbles can raise interest rates without leading to explosive transition paths. Misallocative bubbles which exist in the presence of financial constraints have a particularly stark negative effect on average consumption since such bubbles do not crowd-out inefficient investments.

Related Literature. Samuelson (1958) and Tirole (1985) were among the first to show the potential for the existence of asset bubbles in the presence of dynamic inefficiency. They showed that asset bubbles help overcome dynamic inefficiency to boost consumption by crowding-out the inefficient investments. Tirole (1985) explored the notion of dynamic inefficiency in an economy where the return to capital being lower

than the growth rate is a symptom of overinvestment. Cass (1972) and Zilcha (1990) are related contributions in the literature which suggest tests to identify capital over-accumulation in random capital chains given the lack of 'market signals or market adjustment mechanisms'[1] which could suggest the existence of overinvestment or dynamic inefficiency.

These papers also account for the positive contribution of asset bubbles to welfare since they crowd-out inefficient investments to boost consumption and therefore welfare. Subsequent contributions have further bolstered the reputation of asset bubbles as a source of outside liquidity (Farhi and Tirole (2011)), as a means to facilitate a transfer of resources from savers to financially constrained productive investors (Martin and Ventura (2012)) and as a source of collateral (Miao and Wang (2012) and Martin and Ventura (2016)). These papers have also provided a framework to understand the implications of asset bubbles on economic growth in an environment with limited access to financial resources and have a largely sanguine view of the role of asset bubbles in alleviating financial constraints[2]. My paper provides an additional nuance to the role of asset bubbles in the presence of financial constraints by studying their effect in a macroeconomic scenario with heterogeneous investment projects. I show that asset bubbles that exist in the presence of financial constraints not only crowd-out investments, but may also lower the average productivity of investments by crowding-out highly productive, though financially constrained, industries. The economy presented in my model neither benefits from the crowding-out of inefficient investments (a la Tirole (1985)) or crowding-in of productive investments (a la Farhi and Tirole (2011) or Martin and Ventura (2012)) in the presence of asset bubbles. Consequently, bubbles lower aggregate output, investment and consumption at the steady state.

I am not unique in highlighting potential negative effects of asset bubbles on the long-run efficiency of investments, though the underlying source of inefficiency is unique to my paper. In endogenous growth models, as shown in Grossman and Yanagawa (1993) and Saint-Paul (1992), social returns to investments are higher than private returns owing to the positive externality of R&D on aggregate productivity. In these models, asset bubbles can exist when private returns are lower than the growth rate

[1] Cass (1972), page 220. Cass (1972) identifies overinvestment in a given capital chain as a situation where long-run inefficiency results from inter-temporal decisions that are short-run efficient.

[2] In Martin and Ventura (2012), bubbles crowd-in investments by transferring valuable investment resources from savers to constrained productive investors. Asset bubbles may crowd-out investments when they are sufficiently large, in which case they may or may not be welfare improving.

of the economy (a la Tirole (1985)) even though social returns to investments might be higher than the growth rate of the economy. While endogenous growth models rely on the externality effects of investments, my model relies on financial constraints to show how bubbles can have an insidious effect on long-run growth by crowding-out financially constrained productive investments from the credit market.

I split the discussion of the model into three sections. I introduce the model in section 3.2 and discuss the heterogeneous projects that seek funding in the credit market. In section 3.3, I discuss the credit market equilibria marked by an endogenously evolving credit composition. I study the effect of asset bubbles in credit markets in section 3.4 and conclude in section 3.5.

3.2 Model

I model a standard 2 period OLG (*overlapping generations*) economy where every agent derives utility only from second period consumption. The agents work in the first period and use their savings to invest in projects that convert their investment into capital. These projects are the savings technology available to the agents. The capital resulting from a successful project is used for production in a standard Cobb-Douglas production function ($f(.)$). I assume that all the agents have access to the Cobb-Douglas production function, though it has no bearing on the results. There is perfect competition in the goods market and the ownership of the production function is inconsequential.

Each agent provides labor of measure 1 inelastically. The young of every generation work, earn wages w_t, and invest their wealth in capital projects. Each agent is identified by their type i, where i is drawn from the set $\mathbb{N}$, and can initiate a project specific to its type. The measure of each type in the population is represented by Δ_i. Since the total population measure is 1, $\sum_i \Delta_i = 1$ holds. The project initiated by an agent of type i is characterized by its

- *Productivity* R_i, where R_i is the amount of capital resulting from each unit invested in the project. Without loss of generality, agents are numbered such that $R_1 > R_2 > ... > R_n$.

- *Pledgeability* λ_i, where λ_i is the fraction of the project output that can be pledged to a potential lender. This parameter captures the tangibility of the capital when deployed in a firm. The distribution of this parameter among the agent types is a key driver of the results of the model.

- *Size* 1, where 1 is the investment required to initiate a project[3].

These capital projects are similar to the ones introduced in Matsuyama (2007). Where as Matsuyama (2007) has a homogeneous agent who chooses from a set of possible projects, I embed project heterogeneity among the young of the population. While only one project is funded under equilibrium in Matsuyama (2007), the heterogeneity among the agents leads to an endogenously evolving credit composition where multiple project types can be funded under equilibrium.

Under general equilibrium, there is a unique cost of borrowing (r_t or $r(k_t)$), cost of capital (ρ_t or $\rho(k_t)$) and labour wage rate (w_t or $w(k_t)$) in the economy. While the market clearing credit market interest rate is discussed in the next section, the later two rates are given by [4]

$$\rho_t = \rho(k_t) = f'(k_t) \tag{3.1}$$

$$w_t = w(k_t) = f(k_t) - k_t f'(k_t) \tag{3.2}$$

Let $\{X_i\}_{i\epsilon\mathbb{N}}$ are the measures of the different projects initiated at time period t. The next period capital is a function of the individual project measures and given by,

$$k_{t+1} = \sum_i X_i R_i \tag{3.3}$$

, where X_i is a function of k_t.

Since investing in projects that convert consumption goods to capital is the only way of ensuring consumption in the second period, the total wealth of the younger generation is used to start the capital projects. More formally,

$$w(k_t) = \sum_i X_i(k_t) \tag{3.4}$$

Hence for any time t, equilibrium is determined by the rates $(r_{t+1}, w_t, \rho_{t+1})$ and the measure of funded project types $\{X_i\}_{i\epsilon\mathbb{N}}$. I solve for these rates in an economy with one and two types of agents in section 3.3 using standard general equilibrium arguments.

[3] Matsuyama (2007) considers the effect of project size heterogeneity in project selection in the credit markets. In a credit market the qualitative effect of project size is the same as that of financial constraints and I assume that project size is the same across the agents for tractability.

[4] Since the labour supply equal measure 1 every period, the equilibrium conditions are reflected in terms of capital per labour k_t.

Even though I look at an economy with at most two types of agents, it will be apparent in 3.3.2 that a very similar analysis holds for a more general case with n agent types. I also characterize the steady states of this economy and identify multiple steady states. The discussion on steady states transitions to a discussion on equilibria in the presence of asset bubbles. Finally, I study the crucial role played by financial constraints in the existence of bubbles and the effect of asset bubbles on credit composition in section 3.4.

3.3 Equilibria with heterogeneous projects

3.3.1 Equilibria without financial frictions

I first consider equilibria in an economy with two types of agents who can initiate projects that are financially unconstrained, i.e. $\lambda_1 = \lambda_2 = 1$. At each period, the young supply labor inelastically with measure 1 and invest their wealth in projects which yield capital for use in production in the second period. The law of motion of capital is a direct outcome of the composition of investments in any given period and I begin with a discussion on the role of the credit market in determining the said composition.

Continuing with the notation in section 3.2, r_{t+1} is the credit market interest rate based on market clearing at period t. Therefore, every agent who borrows $1 - w_t$ pays an interest rate of r_{t+1} while enjoying net returns of $\rho_{t+1}R_i$ next period. An agent of type i would invest in a project if and only if investing in the project pays more than lending in the credit market. The participation constraint is thus,

$$\rho_{t+1}R_i - r_{t+1}(1 - w_t) \geq r_{t+1}w_t \tag{3.5}$$

The complete pledgeability of output means the borrowers will compete solely based on their productivity. The above condition thus reduces to

$$\rho_{t+1}R_i \geq r_{t+1} \tag{3.6}$$

Equation 3.6 captures the simplicity of this case. At equilibrium, the more productive agent can always offer a higher return than the less productive type. Hence it is not possible that a less productive type can initiate a project profitably while there are some projects of a higher productivity that have been left unfunded. Even though the projects are funded in order of their productivity, the measure of each type funded under equilibrium depends on the net wealth of the economy. As an illustration, if the wealth of the economy, w_t, is less than Δ_1, the available resources are less than

the measure of available type 1 projects. In this case all the resources of the economy are channeled to type 1 projects. This imposes that equation 3.6 must hold with equality, or $\rho_{t+1}R_1 = r_{t+1}$. The project measures funded at equilibrium at $w_t < \Delta_1$ is, therefore, given by $X_1 = w_t < \Delta_1$, $X_2 = 0$. If on the other hand $w_t > \Delta_1$, the equilibrium interest rate depends upon the marginal investors of type 2. The credit market interest rate r_{t+1} should be such that type 2 are indifferent between lending or initiating a project, i.e. $r_{t+1} = \rho_{t+1}R_2$.

I capture the above arguments in the conditions below in which I characterize the measure of funded projects $\{X_1, X_2\}$ and credit market interest rate (r_{t+1}) as a function of the level of capital (or wealth) in the economy. A similar argument can be used to characterize the credit market interest rate in an economy with more than 2 agents where the level of financial constraints are in the same rank-order as project productivities.

$$(X_1, X_2) = \begin{cases} (w_t, 0) & \text{if } w_t \leq \Delta_1 \\ (\Delta_1, \Delta_1 - w_t) & \text{if } w_t > \Delta_1 \end{cases}$$

and

$$r_{t+1} = \begin{cases} \rho_{t+1} \cdot R_1 & \text{if } w_t \leq \Delta_1 \\ \rho_{t+1} \cdot R_2 & \text{if } w_t > \Delta_1 \end{cases}$$

3.3.2 Equilibria with financial frictions

3.3.2.1 Equilibrium conditions and credit composition

I introduce financial frictions in the model by imposing heterogeneity in project pledgeability. While projects in section 3.3.1 were fully pledgeable, project pledgeability can depend upon the type generating the project. Each project in the model can only be initiated with an investment of a unit of consumption goods. Now projects of type 1, the more productive projects need not be the first projects to be funded in case they are financially constrained to the extent of being priced out of the credit markets. At low wealth levels, agents have to borrow a larger sum to initiate projects and financial constraints play a large role in determining whether a project gets funded at equilibrium. At higher wealth levels, agents grow out of their financial constraints and project productivity matters more in obtaining funding. I discuss the credit market equilibria in an economy with two projects which, unlike the previous sub-section, have different levels of financial constraints.

Given the credit market interest rate r_{t+1} and return to capital ρ_{t+1}, an investor of type i will invest in a project if and only if

$$\rho_{t+1}R_i - r_{t+1}(1 - w_t) \geq r_{t+1}w_t$$

which reduces to equation 3.6, or $\rho_{t+1}R_i \geq r_{t+1}$.

Every agent also faces a borrowing constraint since the net amount they can borrow is restricted by the proportion of their next period wealth, λ_i for agent i, that can be pledged to the creditors. The borrowing constraint is given by

$$\lambda_i\rho_{t+1}R_i \geq r_{t+1}(1 - w_t)$$

$$\frac{\lambda_i\rho_{t+1}R_i}{(1 - w_t)} \geq r_{t+1} \tag{3.7}$$

The above two conditions can be combined to obtain equation 3.8. A financially constrained project is funded if and only if the relation between its project parameters and the credit market interest rate is

$$\frac{\rho_{t+1}R_i}{max(1, \frac{1-w_t}{\lambda_i})} \geq r_{t+1} \tag{3.8}$$

A natural consequence of the above condition is that agents with the highest $R_i/max(1, (1-w_t)/\lambda_i)$ will be the first to initiate a project for a given level of k_t. The above condition indicates a departure from the type of equilibrium presented in section 3.3.1 where projects were initiated in order of their productivity. $R_i/max(1, (1 - w_t)/\lambda_i)$ is a function of k_t and gives rise to a unique ordering of this parameter for the different $i's$ for a given k_t. To clarify this point, the graph in figure 3.1 plots the pledgeability adjusted productivity factor for two agents whose parameters are shown in table 3.1.

Table 3.1: Parameter values for figure 3.1

R_1	1.3	R_2	0.9
λ_1	0.38	λ_2	0.8
Δ_1	0.58	Δ_2	0.35

The equilibrium for the case with financial constraints can be characterized in a fashion quite similar to the one in section 3.3.1. The key difference is that instead of productivity, at each level of k_t, the deciding factor is the pledgeability adjusted index of

productivity. With an increase in k_t the rank order of the pledgeability adjusted productivity indices can undergo changes. For example in figure 3.1, under $\lambda_2 R_2 > \lambda_1 R_1$, for low values of k_t projects of type 2 are undertaken first. Projects of type 1 are preferred over type 2 projects in the credit market at higher levels of k_t. As k_t increases, the low pledgeability of type 1 plays a lesser role since agents have to borrow lesser amounts from the credit market to initiate their projects. Thus, the projects are funded are after they are ordered based on the parameter $R_i/max(1,(1-w_t)/\lambda_i)$.

Market clearing in the credit markets leads to an endogenous credit composition at different levels of wealth in the economy. This free flow of credit across the different projects makes it an interesting framework for studying the effect of bubbles on credit composition. An economy may start with funding projects of lower productivity and then switch to funding projects with higher productivity in case the high productivity projects are financially constrained (right panel of figure 3.2). On the other hand, financially frictions may not have any effect at all, as in the left panel of 3.2, in case the difference in the pledgeabilities of the two project types is not high enough for type 2 projects to crowd-out projects of type 1 at low capital levels.

In the rest of the paper, I consider the case of an economy which satisfies $\lambda_1 R_1 < \lambda_2 R_2$ (presented in the right panel of figure 3.2). The other case with $\lambda_1 R_1 > \lambda_2 R_2$ is less interesting since the more productive types always get funded ahead of the less productive types irrespective of the capital level and the credit composition has a non-evolving feature. When $\lambda_1 R_1 < \lambda_2 R_2$, the less productive agents enter the credit market as borrowers before the more productive agents until a threshold level of capital, $\bar{k}$, is reached. This threshold level of capital is equal to $\bar{k} = 1 - \lambda_1 R_1/R_2$ (proof in the Appendix. 3.6.1). The law of motion of capital and the equilibrium credit market interest rate are determined as per the following conditions :

$$(X_1, X_2) = \begin{cases} (0, w_t) & \text{if } w_t \leq \bar{k} \text{ and } w_t \leq \Delta_1 \\ (w_t - \Delta_2, \Delta_2) & \text{if } w_t \leq \bar{k} \text{ and } w_t > \Delta_1 \\ (w_t, 0) & \text{if } w_t > \bar{k} \text{ and } w_t \leq \Delta_2 \\ (\Delta_1, w_t - \Delta_1) & \text{if } w_t > \bar{k} \text{ and } w_t > \Delta_2 \end{cases}$$

and

$$r_{t+1} = \begin{cases} \frac{\rho_{t+1} \cdot R_2}{max(1, \frac{1-w_t}{\lambda_2})} & \text{if } w_t \leq \bar{k} \text{ and } w_t \leq \Delta_1 \\ \frac{\rho_{t+1} \cdot R_1}{max(1, \frac{1-w_t}{\lambda_1})} & \text{if } w_t \leq \bar{k} \text{ and } w_t > \Delta_1 \\ \frac{\rho_{t+1} \cdot R_1}{max(1, \frac{1-w_t}{\lambda_1})} & \text{if } w_t > \bar{k} \text{ and } w_t \leq \Delta_2 \\ \frac{\rho_{t+1} \cdot R_2}{max(1, \frac{1-w_t}{\lambda_2})} & \text{if } w_t > \bar{k} \text{ and } w_t > \Delta_2 \end{cases}$$

3.3.2.2 Law of motion of capital

For a given level of capital, the credit (and therefore investment) composition is determined the relative tightness of the borrowing constraints of the two sectors of the economy. In this sub-section, I study the implications of the evolving credit market composition on capital accumulation in an economy with two types of agents where the more productive agents face high levels of financial constraints, i.e. an economy which satisfies $R_1 > R_2$ and $\lambda_1 R_1 < \lambda_2 R_2$.

Depending upon how the credit markets clear, our agents might find themselves playing one of 3 roles in the credit market. These roles are that of a -

- *Supra-marginal investors* - agents who strictly prefer borrowing to lending in the credit market.

- *Marginal investors* - agents who are indifferent between borrowing and lending at the market clearing interest rate.

- *Lenders* - agents who provide the credit intermediated to supra-marginal and marginal investors.

In the simple set-up with two types of agents, there are 4 types of equilibria depending upon the supra-marginal and marginal investors. Under the assumption $\lambda_1 R_1 < \lambda_2 R_2$, at levels of capital $k_t < \bar{k}$ (for details on $\bar{k}$, please see sub-section 3.3.2.1), the type 2 agents take precedence over type 1 agents in the credit market since they are financially less constrained and can commit to a higher interest rate than type 1 agents. Therefore, for all $k_t < \bar{k}$, $2 \succ 1$ (*i.e.* $R_2/max(1, (1-w_t)/\lambda_2) > R_1/max(1, (1-w_t)/\lambda_1)$). In the region $k_t < \bar{k}$, we may have either $w_t < \Delta_2$ or $w_t > \Delta_2$, where Δ_2 is the measure of type 2 agents. In case $w_t < \Delta_2$, there are enough type 2 projects to absorb the net wealth of the economy and and only type 2 projects are funded in the credit market. In the case of $k_t < \bar{k}$ and $w_t > \Delta_2$, all the type 2 agents and some type 1 agents are funded. Type 2 agents act as supra-marginal investors and type 1 agents are either lenders or the marginal investors. These are the two type of equilibria that can exist

when $k_t < \bar{k}$. I refer to these equilibria as A and B respectively.

Another set of equilibria can exist when $k_t > \bar{k}$. In this region, $R_1/max(1,(1-w_t)/\lambda_1) > R_2/max(1,(1-w_t)/\lambda_2)$, i.e. $1 \succ 2$. Two equilibria exist characterized by whether $w_t < \Delta_1$ or $w_t > \Delta_2$. In the former case, type1 projects can completely absorb the net wealth intermediated in the credit markets. In the latter case, type 2 agents are the marginal investors after all type 1 projects have been funded. We refer to these equilibria as C and D respectively.

To begin with, at very low levels of capital, the economy finds itself in equilibria of type A since we have $2 \succ 1$ and the measure of type 2 projects is enough to absorb the net wealth of the economy. The type 2 agents are the marginal investors in this region. As the economy progresses, the type2 projects cant completely absorb the wealth of the economy (i.e. when $w_t < \bar{k}$ and $w_t > \Delta_2$) and some type 1 projects enter the credit market as borrowers or marginal investors. This is region B of the law of motion of capital. When the economy crosses the threshold $\bar{k}$, the economy enters the region in which $1 \succ 2$. When type 1 agents are the only investors the economy is in equilibria C. This can change with further wealth accumulation when agents of type2 may again be funded in the credit market. I call the resulting composition equilibria D. The economy, therefore, goes through different phases of economic growth based on the changing credit composition at equilibrium. I show these phases along the law of motion of capital in figure 3.3. The table 3.2 summarizes the 4 different types of equilibria and the interest rate and marginal investor in each type.

Table 3.2: Types of equilibria

Equilibria Type	Supra-Marginal Projects	Marginal Projects	Borrowers	Condition
A	2	2	2	$w_t < \bar{k}$ & $w_t < \Delta_2$
B	2	1	1, 2	$w_t < \bar{k}$ & $w_t > \Delta_2$
C	1	1	1	$w_t > \bar{k}$ & $w_t < \Delta_1$
D	1	2	1, 2	$w_t < \bar{k}$ & $w_t > \Delta_1$

3.3.2.3 Steady states

The economy can find itself in one of the 4 types of equilibria described in the previous sub-section when at steady state. For example, in figure 3.3, the economy has two possible steady states - one each of type B (both types of projects are funded, with type 2 projects as the supra-marginal projects) and C (only type 1 projects are funded). The viable steady states depend upon the parameters of the economy - $\alpha, \{\lambda_i, R_i, \Delta_i\}_{i=1,2}$.

It is the interaction of these parameters that determines the actual steady states of the economy. For example a steady state in which the economy finds itself in equilibria of type A is characterized by a solution to the equation

$$k_A^* = R_2 \cdot (1-\alpha) \cdot k_A^{*\alpha}$$

Such a steady state can exist if and only if the candidate solution k_A^*, the potential steady state in which only type 2 projects are invested, satisfies $k_A^* < \bar{k}$ and $(1-\alpha)k_A^{*\alpha} < \Delta_2$. The two conditions ensure that the steady state value when only type 2 projects are invested is indeed feasible - the first condition ensures that type 2 projects are selected in the credit market to be funded before type 1 projects and the second condition ensures that there are enough type 2 projects to absorb the total wealth of the economy at steady state[5].

The existence condition for a steady state in which the economy is in an equilibria of type B can also be characterized in a similar way. The candidate solution k_B^* of the steady state level of capital in which both the project types are invested and type 1 agents are marginal investors is a solution to the equation

$$k_B^* = R_2 \cdot \Delta_2 + [(1-\alpha) \cdot k_B^{*\alpha} - \Delta_2] \cdot R_1$$

In the above equation, the steady state level of capital is the result of all type 2 projects and a fraction of type 1 projects being funded in the credit market in the previous period. Such a steady state exists if and only if $k_B^* < \bar{k}$ and $R_1(1-\alpha)\bar{k}^\alpha - \bar{k} < \Delta_2(R_1 - R_2)$, the conditions that ensure the feasibility of the candidate solution as a viable equilibrium state. We can similarly state the candidate solutions for steady states of type C and type D and the conditions that qualify their existence. The candidate steady state level of capital when the economy is in an equilibrium of type C (k_C^*) involves investment from only type 1 projects and is a solution to the equation

$$k_C^* = R_1 \cdot (1-\alpha) \cdot k_C^{*\alpha}$$

k_C^* is feasible if and only if $k_C^* > \bar{k}$ and $(1-\alpha)k_C^{*\alpha} < \Delta_1$. Finally, the candidate steady state level of capital when the economy is in an equilibrium of type D (k_D^*) involves both project types being funded, with type 2 projects are marginal investors. k_D^* is a solution to the equation

[5]The two investment projects in the economy continue to satisfy $R_2\lambda_2 > R_1\lambda_1$, as in all other sections on the paper.

$$k_D^* = R_1 \cdot \Delta_1 + [(1-\alpha) \cdot k_D^{*\alpha} - \Delta_1] \cdot R_2$$

and exists if and only if $k_D^* > \bar{k}$ and $\bar{k} - R_2(1-\alpha)\bar{k}^\alpha < \Delta_1(R_1 - R_2)$.

In general all the steady states can co-exist in the same economy except C and D which preclude the existence of each other. I illustrated two economies which have multiple steady states of the types described in this subsection. In figure 3.4, on the left panel I show an economy which has two steady states - one in which the economy is in equilibrium of type B and the second higher steady state in which the economy is in steady state of type C. The economy in the right panel only has a steady state of type C. Finally I note that the same economy can have at most one steady state of each type (even though multiple steady states are possible) and the candidate solutions can be ordered as $k_A^* < k_B^* < k_C^* < k_D^*$

3.4 Equilibria with bubbles

In section 3.3.2, introducing financial frictions into the model added interesting dynamics in the process of capital accumulation, with endogenous credit composition as a function of wealth and multiple steady states. I introduce bubbles in this stylized model to study the aggregate impact of asset bubbles in the credit market. I generate two interesting theoretical results. Firstly, I show that financial constraints create conditions for the existence of asset bubbles by lowering the steady state interest rates in the credit market. Hence the existence of asset bubbles in the economy do not necessarily suggest the presence of dynamic inefficiency in investments. Secondly, I characterize economies in which bubbles not only crowd-out investments but also lower the average investment productivity. The lowering of investment productivity results from the misallocation of credit from high to low productivity agents (or sectors) of the economy. The reduction in investment productivity also lowers average consumption. To the best of my knowledge, my paper is unique in highlighting negative welfare consequences of asset bubbles through their effect on credit composition.

Asset bubbles compete with other assets based on real economic activity for financial resources of an economy. The lenders in the credit market can not tell apart between asset bubbles and other real assets. The exchange between lenders and borrowers takes place through simple promissory notes in the credit market. These promissory notes are redeemed in the same exchange market in the next period and the holders of these notes have no way of knowing whether the returns were the result of their resources being used in actual production or just asset a bubbly inter-temporal transaction.

This section discusses the effect of asset bubbles on aggregate capital accumulation

in the presence of heterogeneous projects described in sections 3.3.2. Asset bubbles can exist in a credit market provided they ensure a return at least as high as the credit market interest rate and provided the lender in a given period is assured of a buyer next period. Any difference in the credit market interest rate and the asset bubble return not comprise a market equilibrium since it would lead to a rush for the instrument with the higher interest rate and subsequent changes in the instrument's price. This helps us establish that the return on the bubble, or the growth rate of the bubble, equals the credit market interest rate as stated in the equation below.

$$E_t \frac{b_{t+1}}{b_t} = r^b_{t+1} \tag{3.9}$$

where, b_t is the value of the bubbles in the current period and b_{t+1} is the value of the bubbles in the next period. r^b_{t+1} is the credit market interest rate in the presence of the bubble. The rest of the equilibrium conditions are similar to the ones described for the equilibria without bubbles.

3.4.1 Bubbly Equilibria with one project type

I start with the case of an economy with only one type of agent who can invest in projects of unit size which generate R units of capital. The pledgeability of these projects is given by $\lambda < 1$. This economy is a special case of the economy presented in section 3.3.2 in which the two types of agents have the same levels of productivity and financial access. Every period, agents borrow from the credit market to initiate the unit size capital projects[6]. The capital resulting from the investment projects is subsequently used in the firms that are Cobb-Douglas aggregators of labour and capital.

At time t, agents prefer to invest in capital projects provided $\rho_{t+1}R \geq r_{t+1}$. Further, the borrowing constraint (discussed in section 3.3.1) for the agents is given by $\lambda\rho_{t+1}R \geq r_{t+1}(1-w_t)$. Since there is only one type of agent in the economy, every agent must be indifferent between borrowing and lending in the credit market. Hence, the relation between the credit market interest rate and the rental rates of labour and capital is determined by which ever of the two constraints binds, i.e., $r_{t+1} = \rho_{t+1}R/max(1,(1-w_t)/\lambda)$.

The equilibrium conditions governing the existence of bubbles when the agents are not constrained are equivalent to those discussed in earlier contributions of the literature,

[6]I only consider equilibria in which the investors are financially constrained. The condition that restricts the parameter space to one in which the agents are always financially constrained also entails that the wages in the economy are not enough to initiate the capital projects without borrowing in the credit market.

most notably Tirole (1985). In this paper I restrict the discussion regarding the effect of asset bubbles when the agents are financially constrained. Specifically, I assume that at the steady state, the borrowing constraint is binding, i.e. $max(1,(1-w^*)/\lambda) = (1-w^*)/\lambda \Rightarrow w^* < 1-\lambda$. Under the above assumption, it is easy to see that the steady state level of capital is $k^* = [R(1-\alpha)]^{\frac{1}{1-\alpha}}$ and the steady state level of credit market interest rate is given by $r^* = \rho^* R\lambda/(1-w^*)$. All the results in the subsequent sections are in the parameter space where $(1-\alpha)\cdot[R(1-\alpha)]^{\frac{\alpha}{1-\alpha}} < 1-\lambda$. This condition ensures that the investors are financially constrained at steady state and is more likely to hold true for low values of the pledgeability parameter λ.

3.4.1.1 Existence condition for bubbly steady states

I consider asset bubbles in an economy in which agents are financially constrained under steady state (i.e., $w^* = (1-\alpha)\cdot[R(1-\alpha)]^{\frac{\alpha}{1-\alpha}} < 1-\lambda$). Asset bubbles are bought and sold purely based on their financial return. These bubbles divert resources away from productive investments and are bought purely because they promise an interest rate equal to the credit market interest rate and as savings instruments, are indistinguishable from other instruments in the credit market. In this section I discuss the existence of steady state levels of capital k_b^*, credit market interest rate r_b^* and aggregate bubble size b^* in the economy described here. I presented the governing equations for steady state levels of capital and credit market interest rate, k^* and r^* respectively, under the fundamental equilibrium in the earlier sub-section. The governing equations for the steady state levels of $\{r_b^*, k_b^*, b^*\}$ in the presence of a bubble are given by,

$$r_b^* = R\lambda \cdot \frac{\alpha k_b^{*\alpha-1}}{1-(1-\alpha)\cdot k_b^{*\alpha}} = 1 \tag{3.10}$$

and

$$k_b^* = R\cdot[(1-\alpha)\cdot k_b^{*\alpha} - b^*] \tag{3.11}$$

The first condition ensures a steady size of bubble given that the economy under consideration has no changes in productivity or population. The second equation is the law of motion of capital given that the net wealth of the economy held by wage earners is allocated into both bubbles and capital by the credit market. I characterize the existence of bubbly steady states in terms of the model parameters in proposition 1.

Proposition I The economy with a single type of agent has steady states with asset bubbles in the credit markets if the parameters of the capital projects satisfy $R\lambda < 1$.

No asset bubbles can exist if $R\lambda > 1$. Further, $R\lambda < 1$ is a necessary, but not a sufficient condition for the existence of equilibria with asset bubbles. The sufficient conditions can be characterized based on the fundamental steady state values of capital and credit market interest rates, k^* and r^* in the following way -

a. The economy has at least one steady state in the presence of asset price bubbles if $r^* < 1$.

b. In case $r^* > 1$, the economy has at least two steady states in the presence of asset bubbles if and only if$k^* > 1$. There are no steady states in the presence of asset bubbles if $r^* > 1$ and $k^* < 1$.

Proof. At steady state, the growth rate of the bubble must equate the growth rate of the economy at steady state, which is 1 in the current model. Therefore, equation 3.10 states that the credit market interest rate must equal the growth rate of the bubbles and hence must be equal to 1. The necessary condition of $R\lambda < 1$ follows directly from this equation. The function $g(k) = \alpha k^{\alpha-1}/(1-(1-\alpha)k^{\alpha})$ has a global minima at $k = 1$, with $min(g(k)) = 1$. Similarly, $min(R\lambda \cdot \alpha k^{*\alpha-1}/(1-(1-\alpha)k^{*\alpha})) = R\lambda$. In case $R\lambda > 1$, the equations 3.10 and 3.11 do not have a real solution in k_b^* and b^* such the equilibrium credit market interest rate can equal 1. Therefore steady state with asset bubbles exist only if $R\lambda < 1$. This result suggests a clear link between financial constraints and the existence of asset bubbles.

$R\lambda < 1$ is not a sufficient condition for the existence of bubbles. The steady state levels of capital and credit market interest rate under fundamental equilibria provide an intuition for the scenarios in which asset bubbles can exist at steady state. It is possible to show there exists atleast one deterministic steady state when $r^* < 1$. The existence of such a steady state can be shown using equation 3.11 where it can be shown that there exists a $k_b < k^*$ such that $R\lambda \cdot \alpha k_b^{*\alpha-1}/(1-(1-\alpha)\cdot k_b^{*\alpha}) = 1$ for a given b^*. Further it is relatively straight forward to show that such a bubble b^* satisfies $0 < b^* < (1-\alpha)\cdot k_b^{*\alpha}$. Hence the pair $\{k_b^*, b^*\}$ qualify as a steady state in the presence of bubbles.

In case of $R\lambda < 1$, $r^* > 1$ and $k^* > 1$, it is possible to show that there exist atleast two candidate solutions $k_{b_1}^* < k^*$ and $k_{b_2}^* < k^*$ that satisfy $R\lambda\cdot\alpha k_b^{*\alpha-1}/(1-(1-\alpha)\cdot k_b^{*\alpha}) = 1$ for two different values of bubbles b_1^* and b_2^* respectively. The two candidate steady state solutions are possible because in each case the condition that bubble can not be larger than the net wealth of the economy at steady state, i.e. $0 < b^* < (1-\alpha)\cdot k_b^{*\alpha}$, is shown to hold. Finally, in case $R\lambda > 1$, $r^* > 1$ and $k^* < 1$, it can be shown that there are no possible solutions $k_b^* < k^*$ which satisfy $R\lambda \cdot \alpha k_b^{*\alpha-1}/(1-(1-\alpha)\cdot k_b^{*\alpha}) = 1$. Since the steady state level of capital in the presence of bubbles can not be larger than the steady state level of capital under fundamental equilibria, the existence of bubbly

steady states can be ruled out in this final case. I discuss the stability property of these different steady states in Appendix 3 *q.e.d.*

Figure 3.5 plots the function $g(k) = \alpha k^{\alpha-1}/(1-(1-\alpha)k^{\alpha})$ with respect to k and highlights how a reduction in the level of financial constraints for the investment projects can give rise to asset bubbles in an economy. The economy in the left panel has high levels of productivity and low levels of financial constraints as a result of which the economy does not satisfy $R \cdot \lambda < 1$. There is no level of asset bubbles which can lead the economy to a steady state in which the credit market interest rate may equal 1, the only possible interest rate in the presence of bubbles. Asset bubbles are possible in the economy represented in the right panel of figure 3.5 which has investment projects with the same productivity but much higher levels of financial constraints. The credit market interest rate in the fundamental steady state for this economy is $r^* < 1$ (not shown in the figure). Crowding-out of investments in the presence of asset bubbles raises the interest rates until a steady state is reached where it exactly equals 1. The downward sloping curvature of the credit market interest rate in the event of crowding-out ensures that such an asset bubble indeed exists.

The above results clarify the crucial role that financial constraints play in the existence of bubbles in economic models with capital projects as defined in Matsuyama (2007). Firstly, similar to the existence condition in Tirole (1985), if the credit market interest rate in the fundamental steady state is less than 1, then the existence of a deterministic bubbly steady state is assured. What this model also shows that even if the fundamental steady state interest rate is not less than 1, the standard condition for dynamic inefficiency, there exist steady states with asset bubbles provided the agents in the economy are faced with high levels of financial constraints.

3.4.2 Bubbly equilibria with two project types

I consider the possibility of asset bubbles in an economy with two types of projects, as were discussed in section 3.3.2. There exist projects of type 1 that are productive but financially constrained and projects of type 2 that are unproductive and financially unconstrained ($R_1\lambda_1 < R_2\lambda_2$). I study whether the presence of asset bubbles can affect the steady states of such an economy.

Bubbles play two roles under equilibrium. Firstly, they transfer resources costlessly across generations. This inter-generational transfer of resources is responsible for increased consumption and credit booms that bubble models in economic literature try to replicate. Bubbles crowd-out investments and lower the law of motion of capital, possibly affecting the steady state of the economy. It is the second role that is unique to this model. In the current model, bubbles can crowd-out productive investments to

the extent that they can lead to steady states in which the unproductive investments are funded even though such a steady state is not possible in the absence of steady states. I call these steady states bubbly growth-traps. Before we study the growth traps, I present the equilibrium equations that govern the law of motion of capital in the presence of bubbles. Let at time t, the capital level of the economy is k_t^b and the value of bubbles is b_t. Equilibrium is given by $\{r_{t+1}^b, w_{t+1}^b, \rho_{t+1}^b\}$ such that r_{t+1}^b clears the credit market in period t and the following equations hold,

- No arbitrage condition - $b_{t+1}/b_t = r_{t+1}$

- Credit market interest rate - $r_{t+1} = R_1\rho_{t+1}/max(1, 1 - w(k_t)/\lambda_i)$ (where i represents the marginal investors)

- Resource constraint - $b_t < w(k_t) \cdot Measure\ of\ lenders$ (note - this measure is determined endogenously)

- Law of motion of capital - $k_{t+1}^b = \sum_i X_i^b R_i$, where X_i^b is the measure of type i that initiates capital projects under credit market equilibrium.

3.4.2.1 Effect of bubbles on steady states

The steady states in the presence of bubbles can potentially be very different from the fundamental steady states of the economy in the presence of heterogeneous projects. For example, in the economy represented by the left hand panel of figure 3.4, there are no fundamental steady states of either type A or B, where type 2 agents (the unproductive agents with low levels of financial constraints) are the supra-marginal investors. These steady states may not occur because of various reasons. Steady states of type A can not exist if the theoretical value of k_A^* do not satisfy either $k_A^* < \bar{k}$ or $w(k_A^*) < \Delta_2$. Similarly a steady state of type B can not exist if $k_B^* < \bar{k}$ or $R_1(1-\alpha)\bar{k}^\alpha - \bar{k} < \Delta_2(R_1 - R_2)$ is not satisfied (details in section 3.3.2.3). As shall be clear in this section, bubbles lower the motion of capital and guide the economy to steady states that are not possible as a fundamental equilibria.

I present the effect of bubbles on steady states in the case with heterogeneous projects in two lemmas.

Lemma I - The existence conditions for steady states in the presence of bubbles in which either type 1 and type 2 agents are the only investors are similar to the conditions described in Proposition 1. Therefore, even in the heterogeneous projects case, steady states of type A (in which only type 2 agents invest) are possible if $R_2\lambda_2 < 1$ and the fundamental steady state values of $\{r^{A*}, k^{A*}\}$[7] are as per the conditions stated in

[7]These are the steady state values the economy would reach under fundamental equilibrium if type 2 agents were the only investors in the economy. Such a steady state may not be reached in a heterogeneous project economy, as is the case in the economies shown in figure 3.4.

Proposition 1.

The statement in Lemma 1 is self-evident. I do not qualify the existence conditions of steady states in the presence of bubbles in which both the agents borrow from the credit market. Instead, I focus on the feasibility of bubbly steady states when either the productive or unproductive agents are the sole investors to present an intuition for the bubbly growth traps in the most straight forward way possible.

Lemma II - Bubbles relax the necessary conditions for the existence of steady states in which the less productive agents are the investors. Bubbles can thus generate steady states of type A (bubbly growth traps) even though steady states in which only the unproductive agents are the sole investors do not exist as a fundamental equilibrium.

Proof. If steady states of type A do not exist as a fundamental equilibrium, then either $w(k_A^*) > w(\bar{k})$ or $w(k_A^*) > \Delta_2$. Since $k^{A*} > k_b^{A*}$, where k_b^{A*} is the level of capital when the economy is in a bubbly steady state of type A, bubbles seem to relax the existence conditions for bubbly steady states of type A. Hence even if $w(k^*) > w(\bar{k})$, we can have $w(k_A^{b*}) < w(\bar{k})$ since $k_A^* > k_A^{b*}$.

A similar argument holds for the steady state of type B. Let us imagine that in the absence of bubbles $R_1(1-\alpha)\bar{k}^\alpha - \bar{k} < \Delta_2(R_1 - R_2)$ or $w(k^{B*}) > \triangle_2$ are violated. The existence condition for steady state of type B in the presence of bubbles are $R_1(1-\alpha)\bar{k}^\alpha - \bar{k} < \Delta_2(R_1 - R_2) + R_1 b^*$ and $w(k_b^*) > \triangle_2$. Since $k_B^* > k_B^{b*}$, we again see that bubbles relax the condition for the existence of steady states of type B. Hence even if $R_1(1-\alpha)\bar{k}^\alpha - \bar{k} < \Delta_2(R_1 - R_2)$ is not satisfied, the condition $R_1(1-\alpha)\bar{k}^\alpha - \bar{k} < \Delta_2(R_1 - R_2) + R_1 b^*$may be satisfied in the presence of bubbles.

Figure 3.6 shows a simple case in which lemma 1 and 2 can be seen in practice. In the left panel, I show the law of motion of capital in an economy which does not have a fundamental steady state of type A. I select parameters such that bubbly steady states of type A are feasible in this economy ($R_2\lambda_2 < 1$,$r^{A*} < 1$ and $k^{A*} < 1$, suggesting at least one bubbly steady state of type A). The right panel of figure 3.6 shows the level of the bubbly steady state of type A with respect to the original fundamental steady state of type C in which only the more productive agents of type 1 invest the net wealth of the economy. The bubbly steady state k_b^{A*} is far lower than the steady state level of capital in case either of the two agents were the sole investors in the economy ($k^{A*}$and k^{C*}). In this economy, bubbles crowd-out real investments from the more productive investors until a point when not only the order in which the projects are funded at equilibrium is changed, it also leads to a steady state in which the more productive projects completely cease to be funded. The economy stays at this low level of capital as long as the bubble exists. In the absence of the bubble, the natural tendency of the economy is to progressively invest its resources into capital until there

is enough wealth for the productive agents to not be financially constrained anymore. This transition does not take place in the presence of bubbles and therefore the bubbly steady state acts a growth trap.

,

3.5 Conclusion

I studied an economy with two sectors in which asset bubbles affect the composition of investments at steady state. The economy has a productive albeit financially constrained sector and an unproductive sector with lower levels of financial constraints. Such a economy grows in phases where the accumulation of wealth lowers the financial constraints for the high productivity, financially constrained sector. With economic growth, the economy transitions from a low growth rate phase to a phase marked with high investment productivity, consumption and faster growth rates. In such an economy, asset bubbles not only crowd-out investments, but absorb valuable financial resources that if used in real economic activity provide the wealth essential for initiating the productive, financially constrained projects in the future. I shared an example of an economy where the loss of financial resources to asset bubbles completely rules out the transition to the high investment productivity phase since the economy never acquires the wealth necessary to make the said transition. Such a steady state with low investment productivity, which the economy would have otherwise grown out of in the absence of asset bubbles, is a bubbly *growth trap*. The *growth trap* is marked by low levels of wealth and consumption that are the direct consequence of the low investment productivity. To the best of my knowledge, this is the first paper to highlight the negative welfare consequences of asset bubbles through their effect on credit composition.

The model presented in this paper is also quite general in the way the framework presented can be tweaked to replicate other important contributions to the literature. I showed that asset bubbles resulting from dynamic inefficiency (a la Tirole (1985)) are a sub-set of all the possible asset bubbles in this model. Asset bubbles that are the result of financial constraints are particularly insidious since the investments they crowd-out are not inefficient. While the effect of asset bubbles on credit composition in my paper is in stark contract to the one presented in Martin and Ventura (2012), I do not believe my results contradict theirs in any way. The results in my paper emphasize the need for a careful understanding of the resources that drive the growth of an asset bubble. If the bubbles drive growth in a sector by intermediating scarce resources to a productive, financially constrained sector, the effects are likely to be different from that of an

asset bubble that crowd-outs the current and future financial resources of productive industries. This model also provides a complementary view to the one presented in Farhi and Tirole (2011) on the effect of financial constraints on the existence of bubbles. Finally, the framework in my paper also broadens our understanding of pareto destroying asset bubbles by highlighting a channel distinct from the one presented in the literature on endogenous growth models (such as Grossman and Yanagawa (1993)).

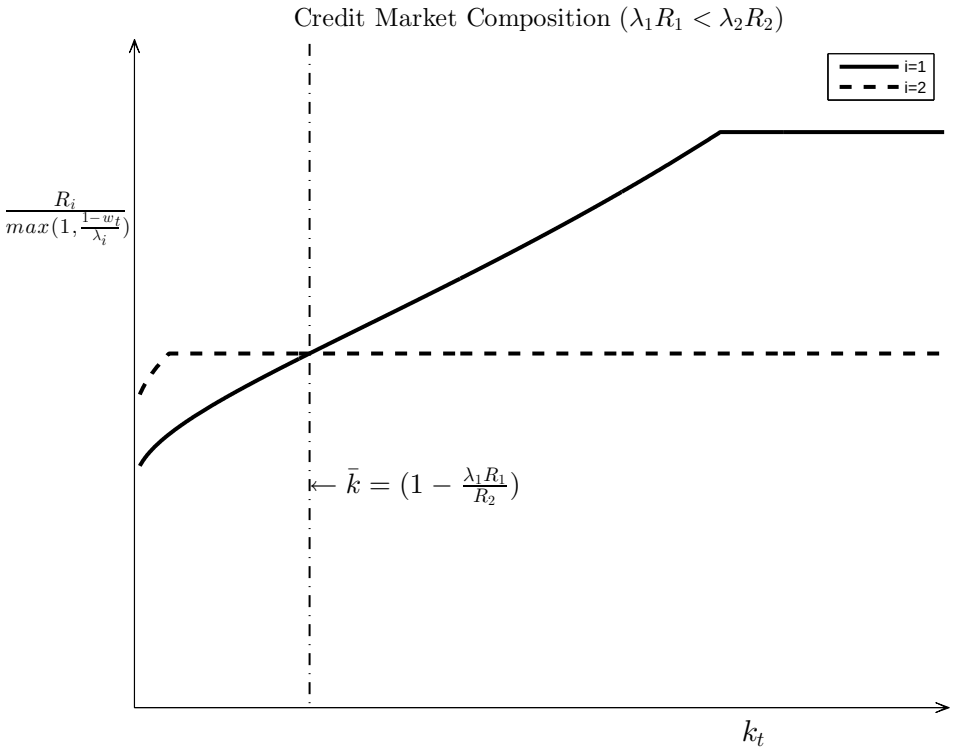


Figure 3.1: Pledgeability adjusted productivity parameters for the two possible investments

The above figure shows the order in which projects (type 1 or type 2) are funded for different levels of capital, k_t in the economy. In the figure, the projects with a higher pledgeability adjusted parameter are always the first projects to be funded in the credit market. Type 1 agents are more productive $R_1 > R_2$ but more financially constrained. Hence at low levels of capital when agents have to borrow larger sums to fund their projects, the financial constraints matter more and type 2 projects are the first to be funded. This order changes as the economy grows richer and projects are funded in the order of their productivity and not pledgeability. The parameters used to generate the above figure are $\lambda_1 = 0.38, R_1 = 1.3, \lambda_2 = 0.8, R_2 = 0.9$.

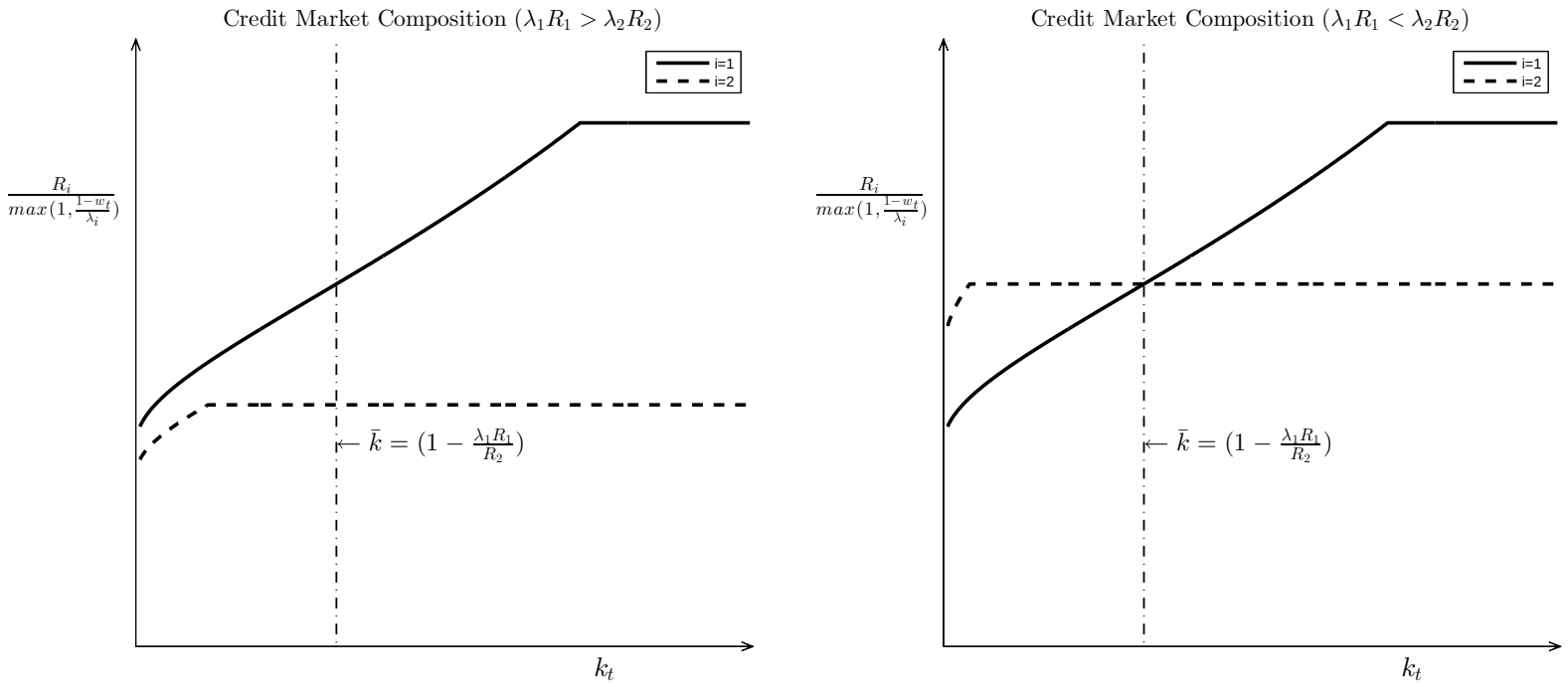


Figure 3.2: Benchmark cases of economies with financial frictions.

The above figure shows that in an economy with $R_1\lambda_1 > R_2\lambda_2$, the type 1 agents are not only more productive but also have a pledgeability such that projects of type 1 are always funded before type 2 projects (left panel). In such an economy, the financial constraint of individual projects does not matter even if $\lambda_1 < \lambda_2$. This is not the case for the economy with $R_1\lambda_1 > R_2\lambda_2$ (right panel) where the less productive type 2 projects are funded before the type 1 projects at low levels of capital. The parameters used to generate the above figure are $\lambda_1 = 0.38, R_1 = 1.3, \lambda_2 = 0.7, R_2 = 0.6.$ for the left panel and $\lambda_1 = 0.38, R_1 = 1.3, \lambda_2 = 0.8, R_2 = 0.9.$ for the right panel.

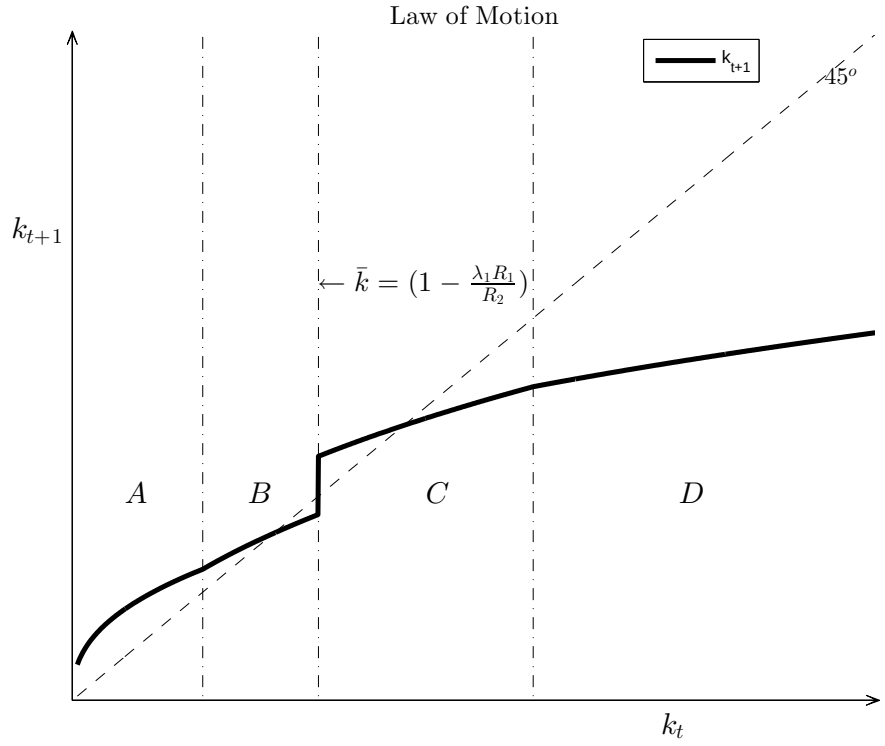


Figure 3.3: Capital accumulation without bubbles

The above figure shows the law of motion of capital for an economy with $R_1\lambda_1 < R_2\lambda_2$ (also figure 3.1). The economy can be in one of four types of equilibria based on the supra-marginal and marginal projects that are funded in the economy. At low levels of capital, only projects of type 2 are funded (A equilibria). After all type 2 projects are funded, type 1 projects are funded for slightly higher levels of capital (B equilibria), before the order in which projects are funded changes for $k > \bar{k}$. For levels of capital higher than $\bar{k}$, there are two types of equilibria - C equilibria in which only type 1 projects are funded or D equilibria in which both type 1 and type 2 projects are funded. The parameters used to generate the above figure are $\lambda_1 = 0.38, R_1 = 1.3, \Delta_1 = 0.58, \lambda_2 = 0.8, R_2 = 0.9, \Delta_2 = 0.35$ and $\alpha = 0.4$.

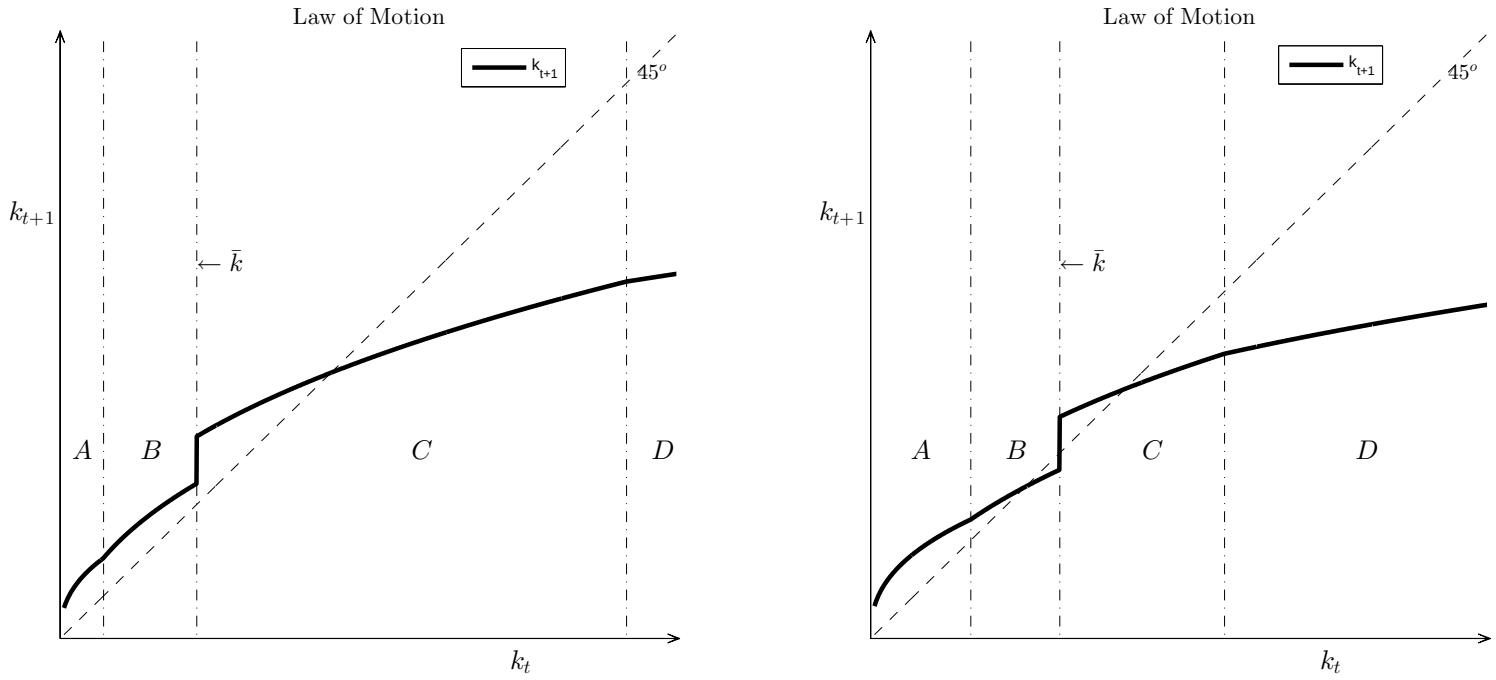


Figure 3.4: Capital accumulation without bubbles

The above figure compares the law of motion in an economy where credit is directed to the productive type 1 projects at steady state (left panel) against an economy where two steady states are possible (right panel). The economy on the right has a steady state in which the type 2 projects are the supra-marginal investors for levels of capital and another steady state for high levels of capital in which the type 1 projects take over that role. The parameters used to generate the above figure are $\lambda_1 = 0.38, R_1 = 1.35, \Delta_1 = 0.7, \lambda_2 = 0.8, R_2 = 0.85, \Delta_2 = 0.25$ for the left panel and $\lambda_1 = 0.38, R_1 = 1.3, \Delta_1 = 0.58, \lambda_2 = 0.8, R_2 = 0.9, \Delta_2 = 0.35$ for the right panel. For each law of motion, $\alpha = 0.4$.

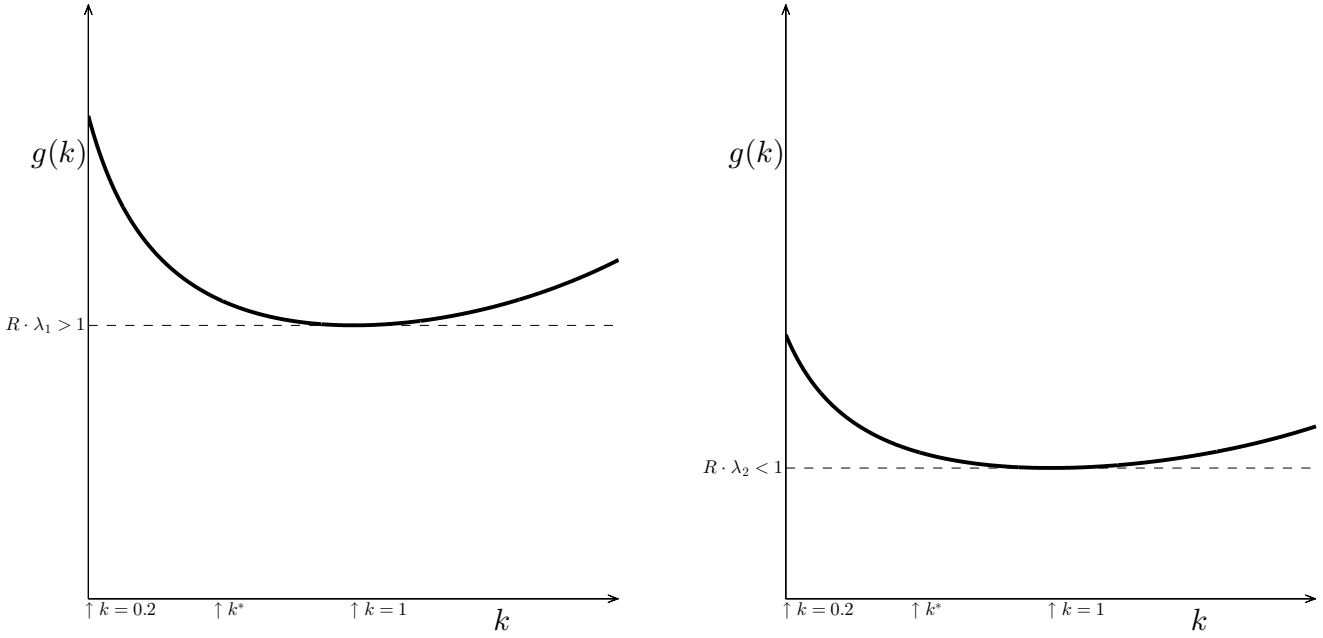


Figure 3.5: Global minima of $g(k)$

The above figure shows the global minima of the function $g(k) = \alpha k^{\alpha-1}/(1-(1-\alpha)k^{\alpha})$ at $k = 1$ for two separate cases. The global minima represents the lower bound of the credit market interest rate possible in the presence of investment projects $\{R, \lambda\}$. In the left panel, based on the parameters $R = 1.2, \lambda_1 = 1.1, \alpha = 0.4$, no asset bubbles are possible at steady state since the credit market interest rate can never be lower than 1 in the given economy ($R \cdot \lambda > 1$). In the right panel, based on the parameters $R = 1.2, \lambda_2 = 0.7, \alpha = 0.4$, the economy satisfies the conditions for the existence of asset bubbles as per Proposition 1 ($R \cdot \lambda < 1$ and the credit market interest rate in the fundamental steady state is less than 1). There exists a steady state bubble size for which the credit market interest rate in the economy represented in the right panel equals 1. The economies above highlight how an increase in financial constraints can create the conditions necessary for the existence of asset bubbles through the lowering of the credit market interest rate.

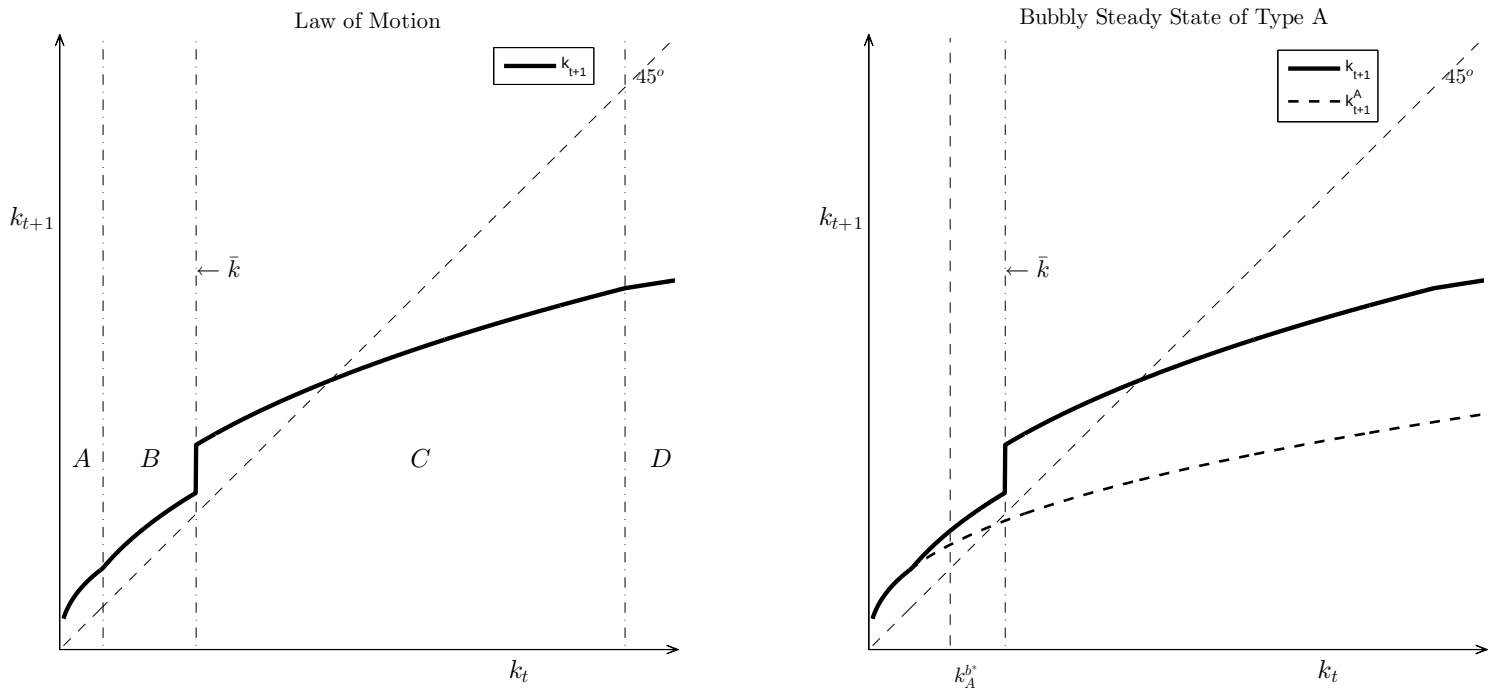


Figure 3.6: Bubbly growth traps

The above figure shows an economy that does not have any steady states in which only the type 2 projects are funded (or A-type equilibria) in the left panel. In the right panel, I show a steady state in the presence of bubbles in which only type 2 projects are funded (k^{A*}). This steady state exists at levels of capital higher than those in which A type equilibria generally exist in the absence of bubbles. Such bubbles crowd-out investments in the economy and lower the low of motion of capital to to an extent that the economy finds itself in a bubbly growth trap.

3.6 Appendix

3.6.1 Analytical expression for $\bar{k}$

$\bar{k}$ is the lowest level of capital at which the more productive investors of type1 are able to muscle out investors of type2 as the supra-marginal investors of the economy. Hence, it is the first level of capital at which $R_1/max(1,(1-w_t)/\lambda_1) = R_2/max(1,(1-w_t)/\lambda_2)$. It is easy to see that at this level of $\bar{k}$, type2 agents must be financially unconstrained, since otherwise the equality cant hold (note - $\lambda_1 > \lambda_2$ and $R_1\lambda_1 < R_2\lambda_2$). Hence $\bar{k}$ is obtained by solving $R_1/max(1,(1-w_t)/\lambda_1) = R_2$.

3.6.2 Necessary conditions for steady states of type B & D

For a steady state of type B, k_B^* must satisfy

$$k_B^* = R_2 * \Delta_2 + [(1-\alpha)k_B^{*\alpha} - \Delta_2] * R_1$$

and $k_B^* < \bar{k}$. The expression above can be written as

$$k_B^* + \Delta_2(R_1 - R_2) = R_1(1-\alpha)k_B^{*\alpha}$$

It can be then shown graphically that a solution to the above equation would reach a solution before $\bar{k}$ if $\bar{k} + \Delta_2(R_1 - R_2) < R_1(1-\alpha)\bar{k}^\alpha$. This reduces to the required expression. A similar condition can also be found for the steady state of type D.

3.6.3 Stability property of the bubbly steady states

I analyze the stability property of the bubbly steady states discussed in section 3.4 to check the behavior of the system close to the steady state of the following system of dynamic equations.

$$k_{t+1} = R \cdot [(1-\alpha) * k_t^\alpha - b_t]$$

$$\frac{b_{t+1}}{b_t} = R\lambda \cdot \frac{\alpha k_{t+1}^{\alpha-1}}{1-(1-\alpha)k_t^\alpha}$$

As I discussed in proposition 1, when the fundamental equilibria steady state r^*satisfies $r^* < 1$, there exists atleast one bubbly steady state with $k_b^* < k^*$. There are atleast two such bubbly steady states when $r^* > 1$ and $k^* > 1$.

The type of bubbly steady states that exist when $r^* < 1$ are similar to the ones that exist in Tirole (1985). $r^* < 1$ is indicative of dynamic inefficiency in the fundamental

steady state in which the return to capital is less than the growth rate of the economy. As was the case in Tirole (1985), such bubbly steady state is saddle path stable. The behavior of the two candidate bubbly steady states identified in proposition 1 for the case $r^* > 1$ and $k^* > 1$ is done by analyzing the eigenvalues of the Jacobian matrix of the dynamic system described above. The Jacobian matrix, evaluated at the steady state is given by

$$\begin{bmatrix} R(1-\alpha)\alpha k_b^{*(\alpha-1)} & (-R) \\ R\alpha(1-\alpha)k^{*(\alpha-1)}b^*[\frac{\alpha-1}{k^*} + \frac{1}{R^2\lambda\alpha k_b^{*(\alpha-1)}}] & 1 + \frac{Rb^*(1-\alpha)}{k_b^*} \end{bmatrix}$$

I use standard parameters and find that of the two steady states one acts as a saddle point and the other (the one with a larger value of capital at steady state) acts as a focus. Further, simulation also show that such a focus can act as both a sink or a source, indicating the dependence of the exact nature of this particular type of steady state on the parameter values. Figure 3.7 presents some simulations to highlight the above results for economies which satisfy the necessary condition (for bubbly steady states) of $R\lambda < 1$. The top left quadrant is an economy in which the level of capital at the fundamental steady state, k^*, is less than 1, while $r^* > 1$. Such an economy does not have any bubbly steady states. The economy on the bottom quadrant has one steady state ($r^* < 1$) and the economy on the right quadrant has two steady states ($r^* > 1, k^* > 1$).

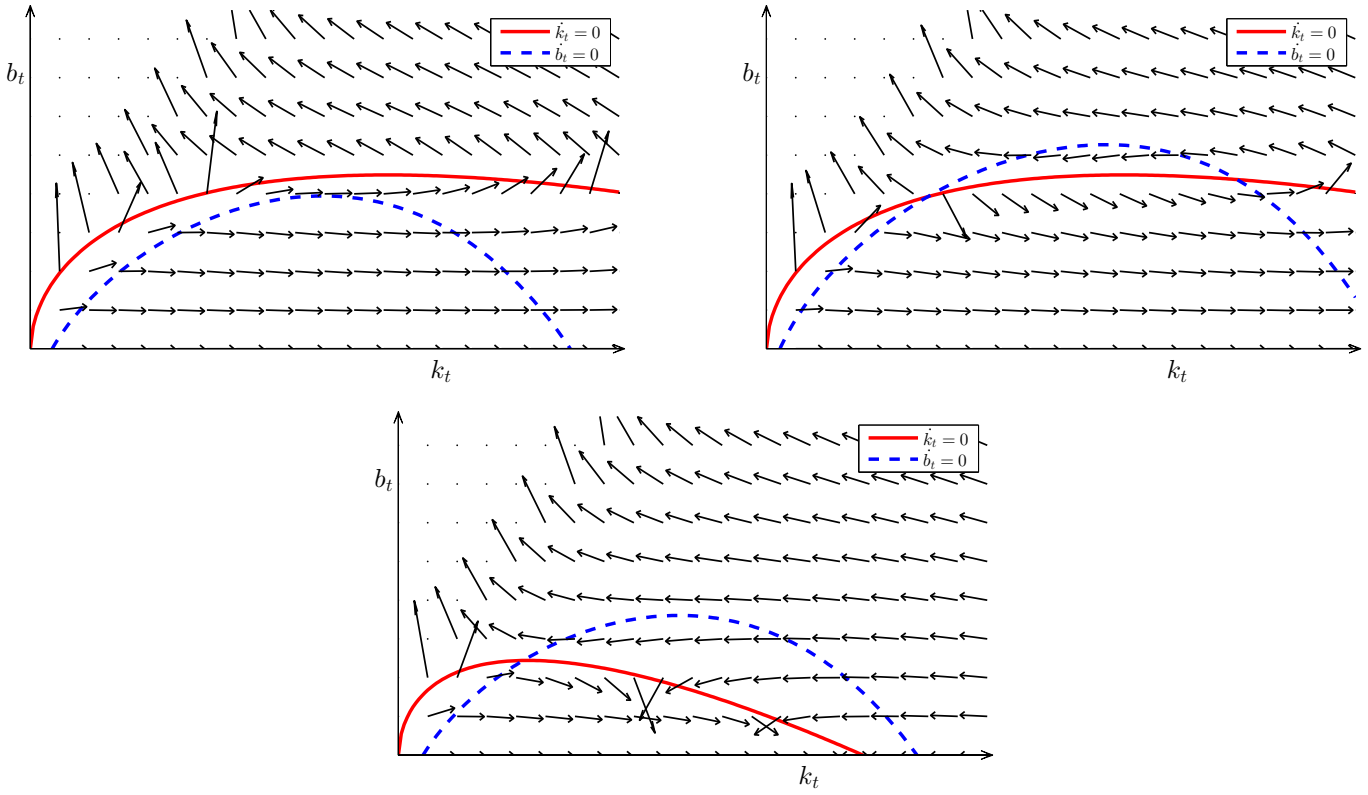


Figure 3.7: Different types of bubbly steady states

The above figure highlights the multiple equilibria possible in the economy described in this paper. I plot combinations of k_t and b_t that can be a potential equilibrium for the economy and identify the steady states of the economy. The economy may not have a steady state with bubbles (top left) or one unique bubbly steady state (bottom). A single steady state is always a saddle point. The economy may also have two steady states (top right) one of which acts as a saddle point and the other a focus. The steady state that acts as a focus can be a sink or source based on the parameters of the economy.

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