IE UNIVERSIDAD

TESIS DOCTORAL / DOCTORAL DISSERTATION

LOS EFECTOS DE LOS ESTÍMULOS Y LOS CHOQUES DE LAS NOTICIAS EN LAS EMPRESAS Y LOS BIENES RAICES/ THE EFFECTS OF STIMULI AND NEWS SHOCKS ON FIRMS AND REAL ESTATE

Rajdeep Chakraborti

SEGOVIA, 2023

IE UNIVERSIDAD

TESIS DOCTORAL / DOCTORAL DISSERTATION

LOS EFECTOS DE LOS ESTÍMULOS Y LOS CHOQUES DE LAS NOTICIAS EN LAS EMPRESAS Y LOS BIENES RAICES/ THE EFFECTS OF STIMULI AND NEWS SHOCKS ON FIRMS AND REAL ESTATE

Rajdeep Chakraborti

Dissertation Advisor: Pedro Gete

Abstract

This dissertation consists of three chapters. In Chapter 1 we show that executive ownership is a significant driver of the demand for credit following credit expansion policies. Our focus on credit demand is in contrast to most studies that have focused on credit supply factors such as bank-capital. Our identification exploits the large and unexpected Chinese credit expansion in 2008. This setting offers a unique advantage as in 2008 the Chinese government had almost complete control over the banking sector and it directed the banks to increase credit supply. Thus, in this setting, demand, rather than supply, largely drives the observed changes in firms' borrowing.

In Chapter 2 we study a model in which leverage and compensation are both choice variables for the firm and borrowing spreads are endogenous. We show that allowing for endogenous compensation and leverage can explain the conflicting findings of the empirical literature. We uncover a new channel of complementarity between effort and leverage that induces a correlation sign opposite to what current theoretical models predict. We also study the dynamics of leverage and compensation design after a credit stimulus. We derive a set of new empirical predictions. For outward-shifts in credit supply, greater CEO pay-performance sensitivity implies higher leverage growth. Moreover, variable compensation increases after the credit stimulus, especially for firms with low idiosyncratic risk.

In Chapter 3 we study the effects of news about sea level rise on housing markets. We exploit two natural experiments in Spain. In 2007 and 2014, Greenpeace published two alarming reports predicting catastrophic consequences for La Manga, a tourist peninsula. These reports were widely cited in the local news. We find that both reports caused immediate and persistent drops in housing prices in La Manga but had no effect on housing rents. The transaction numbers in La Manga remained unchanged post 2007 report but dropped after the 2014 report. Difference-in-differences regressions with different control groups confirm the results. We find persistent drops in average transaction price in La Manga around 4% to 24% and in listing price of around 5% to 10% post publication of the reports. We also find an additional 2% to 4% drop in average transaction price in La Manga by the Spanish buyers relative to the foreign buyers. Transaction number also drops by 9% post 2014 report.

Resumen

Esta disertación consta de tres capítulos. En el Capítulo 1 mostramos que la propiedad ejecutiva es un impulsor significativo de la demanda de crédito después de las políticas de expansión crediticia. Nuestro enfoque en la demanda de crédito contrasta con la mayoría de los estudios que se han centrado en factores de oferta de crédito como el capital bancario. Nuestra identificación explota la gran e inesperada expansión del crédito Chino en 2008. Este entorno ofrece una ventaja única ya que en 2008 el gobierno Chino tenía un control casi total sobre el sector bancario y ordenó a los bancos aumentar la oferta de crédito. Por lo tanto, en este escenario, la demanda, más que la oferta, impulsa en gran medida los cambios observados en el endeudamiento de las empresas.

En el Capítulo 2 estudiamos un modelo en el que el apalancamiento y la compensación son variables de elección para la empresa y los márgenes de endeudamiento son endógenos. Mostramos que permitir la compensación y el apalancamiento endógenos puede explicar los hallazgos contradictorios de la literatura empírica. Descubrimos un nuevo canal de complementariedad entre el esfuerzo y el apalancamiento que induce un signo de correlación opuesto al que predicen los modelos teóricos actuales. También estudiamos la dinámica del apalancamiento y el diseño de compensaciones luego de un estímulo crediticio. Derivamos un conjunto de nuevas predicciones empíricas. En el caso de cambios hacia el exterior en la oferta de crédito, una mayor sensibilidad del desempeño salarial de los directores ejecutivos implica un mayor crecimiento del apalancamiento. Además, la compensación variable aumenta después del estímulo crediticio, especialmente para las empresas con bajo riesgo idiosincrático.

En el Capítulo 3 estudiamos los efectos de las noticias sobre el aumento del nivel del mar en los mercados inmobiliarios. Explotamos dos experimentos naturales en España. En 2007 y 2014, Greenpeace publicó dos informes alarmantes que predecían consecuencias catastróficas para La Manga, una península turística. Estos informes fueron ampliamente citados en las noticias locales. Encontramos que ambos informes causaron caídas inmediatas y persistentes en los precios de la vivienda en La Manga pero no tuvieron efecto en los alquileres de vivienda. Los números de transacciones en La Manga se mantuvieron sin cambios después del informe de 2007, pero cayeron después del informe de 2014. Las regresiones de diferencias en diferencias con diferentes grupos de control confirman los resultados. Encontramos caídas persistentes en el precio promedio de transacción en La Manga alrededor del 4% al 24% y en el precio de cotización de alrededor del 5% al 10% después de la publicación de los informes. También encontramos una caída adicional del 2% al 4% en el precio promedio de transacción en La Manga por parte de los compradores españoles en relación con los compradores extranjeros. El número de transacciones también cae un 9% después del informe de 2014.

Acknowledgements

I express my sincere appreciation to those who have contributed to this thesis and supported me during this beautiful and challenging journey. Without them this research work would not have been possible.

First and foremost, I am extremely thankful to my advisor and mentor, Pedro Gete for his continuous guidance, unwavering support, patience and encouragement. Specifically, Pedro has inspired me and continues to inspire me to become a perfectionist like him. I am also immensely thankful to Sandeep Dahiya for his support in the journey towards the completion of my dissertation. I learnt a lot from both of them, and I am forever grateful.

I am especially thankful to the members of my dissertation committee; namely: committee president Sandeep Dahiya, Clara Martinez-Toledano, Vahid Saadi, Daniel Fernandez Kranz, and Franco Zecchetto. Their comments helped me to improve my thesis and have helped me to generate new research ideas for future research papers.

The papers included in this thesis have greatly benefited from valuable comments from other researchers whom I met during various conferences. I also owe a lot to my wonderful teachers and other academicians who have helped me with their suggestions whenever I approached them. Especially I want to thank Shameek Sinha, Marco Caserta and Emmanouil Avgerinos for the doctoral courses they taught which helped me to take my first steps as a researcher.

The chapters of this thesis are based on joint work with my wonderful co-authors Pedro Gete, Sandeep Dahiya, Clara Martinez-Toledano and Lei Ge. I greatly appreciate the opportunity to work with them and admire their commitment, brilliance and patience with me. I thank them for their approval to incorporate these chapters in my thesis.

I am immensely grateful to my parents and to my friends, especially Sreyaa, Antoaneta, David and Prana who made this long and arduous journey an enjoyable one. I dedicate this thesis to all the above mentioned people without whose support it would not have been possible.

Table of Contents

General Introduction

Unexpected shocks demand policymakers and different sectors of economy to undertake extraordinary steps to overcome them. A key feature of such unexpected shocks is that they cause an immediate and long lasting impact on the whole economy or on a specific sector of the economy. Such a shock may have an immediate impact on the economy or can be seen as a warning regarding a future threat of an even bigger shock. Therefore, the impacts and the steps required to recover from these two different types of shocks require different mitigation measures.

In this thesis I use both these types of shocks. As an unexpected shock that caused an immediate impact, I use the Chinese credit expansion policy of 2008. This credit expansion policy was introduced as an extraordinary measure to overcome the impact of the great recession of 2008 and had an impact on the overall economy. Existing literature examining the effectiveness of such credit expansion policies has mostly focused on banks' willingness to lend. For example, Bebchuk and Goldstein (2011) develop a model to predict the lending patterns of the banks for firms with good projects. Gambacorta and Shin (2018) provide a theoretical overview of this "bank lending channel". They argue that the supply factors can also lead to an increase in unprofitable lending.

However, there remains a largely unexplored alternate channel focusing on the demand of such credit policies. Studies such as Agarwal et al. (2018) show that consumers' propensity to borrow is key in explaining how much additional credit the economy generates. Edmans and Gabaix (2016) survey this growing stream of literature. However, most of the literature in this stream focuses on the household credit demand. There is a scarcity of studies focusing on the impact of corporate demand on the credit generation in an economy.

On the other hand, I use the two Greenpeace reports published in 2007 and in 2014 with focus on La Manga as unexpected news shocks warning of a future existential threat. I use the future inundation threat of La Manga due to sea level rise as the existential threat that the 2007 and 2014 Greenpeace reports are warning about. I focus on the real estate sector to explore the impact of these Greenpeace reports.

A debate exists on how and when housing markets will capture the threat of such a climate risk in housing price. For example, Bernstein et al. (2019) or Giglio et al. (2021) show a negative relationship between climate risks and property prices. On the other hand, Murfin and Spiegel (2020) fail to find any relationship between climate risk and housing price. Finally, Keys and Mulder (2020) show a positive relationship between climate risk and housing prices. However, most of the existing literature capture the impact of actual climate risk (e.g., flooding, sea level rise or hurricane exposure) on housing market. However, there is a scarcity of papers focusing on news shocks that alter beliefs about sea level rise (SLR). Agarwal et al. (2021) is one of the rare exceptions which use information shocks regarding future threat of sea level rise as the cause of change in climate beliefs. I contribute to this rarely explored stream of literature by exploring if climate news shocks can impact the localized housing market in La Manga.

The first chapter explores how the private corporate sector reacts to the large and unexpected 2008 Chinese credit stimulus. The ultimate goal for any credit expansion policy is to induce greater borrowing by corporations. I find that firms react differently when faced with an increased credit supply. This chapter focuses on an important source of this heterogeneous response to the positive 2008 Chinese credit shock, namely: the executive compensation structure. Since Chinese government has a strong control over the banking sector, Chinese government can force the banks to increase credit supply. Thus, demand, rather than supply, largely drives the observed changes in firms' borrowing in this study. I find that this 2008 Chinese credit expansion policy motivates the executives with higher variable pay to borrow more.

The second chapter provides a theoretical model focusing on three important questions related to executive compensation structure and its impact on the CEO's incentive to borrow more and the firm's sensitivity to the 2008 Chinese credit stimulus. Existing models in literature have used at least one of the previous three elements as exogenous. This paper is different from the rest of the literature as the model of this paper uses CEO's compensation, firm's leverage and borrowing spreads all as endogenous.

The model shows that the optimal compensation package is a combination of fixed and variable components both motivates a CEO to exert costly effort and provides enough protection to the CEO's self financial interest. As the firm leverage and the CEO's effort are complementary to the shareholder, the optimal compensation package need to have total pay increasing in leverage. This increased compensation package also can make these firms more sensitive to future policy stimulus. Finally, the model shows that firms with high executive ownership will borrow more in response to an increased credit supply. Thus the findings uncover a potential channel, which can play an important role in the effectiveness of credit policies.

The third chapter show that prices react to impactful news shocks related to future climate risk. This paper exploits the 2007 and 2014 Greenpeace reports claiming the existential threat of La Manga due to future sea level rise. The results show that average transaction price in La Manga react negatively to the Greenpeace reports with respect to a range of control groups. The results indicate a similar trend for listing price as well. However, as theory predicts, the results fail to observe any change in the rental markets. This suggests that markets are pricing the future reallocation of population. Furthermore, While the price effects are strong and statistically significant, these effects are even stronger for Spanish home buyers. The results also indicate that buyers keep on buying properties but at lower prices unless their threat of climate risk is reinforced. These findings suggest that buyers are willing to take risk of climate change by purchasing properties in La Manga but at a lower price level. Thus, we can conclude that, at least while sea level rise is more of a menace than a real danger, most of the effects will be felt in prices. Additionally, local home buyers, who are aware of such threats, will incorporate this climate threat while deciding their transaction prices.

Take together, the three chapters of this thesis contribute to the existing literature on multiple fronts. The first two chapters of the thesis focus on proposing and providing empirical support to the "demand" side of the credit policies. Furthermore, chapter two uses the novel concept of using CEO compensation, firm's leverage and borrowing spreads all as endogenous in a theoretical model. The third chapter provides empirical evidence to the rarely explored stream of literature focusing on climate news shocks.

Introducción General

Choques inesperados exigen que los políticos y los diferentes sectores de la economía tomen medidas extraordinarias para superarlos. Una característica clave de estos shocks inesperados es que provocan un impacto inmediato y duradero en toda la economía o en un sector específico de la economía. Tal shock puede tener un impacto inmediato en la economía o puede verse como una advertencia sobre la amenaza futura de un shock aún mayor. Por lo tanto, los impactos y los pasos necesarios para recuperarse de estos dos tipos diferentes de perturbaciones requieren diferentes medidas de mitigación.

En esta tesis utilizo ambos tipos de choques. Como un shock inesperado que causó un impacto inmediato, utilizo la política de expansión crediticia China de 2008. Esta política de expansión crediticia se introdujo como una medida extraordinaria para superar el impacto de la gran recesión de 2008 y tuvo un impacto en la economía en general. La literatura existente que examina la eficacia de tales políticas de expansión crediticia se ha centrado principalmente en la disposición a prestar de los bancos. Por ejemplo, Bebchuk y Goldstein (2011) desarrollan un modelo para predecir los patrones de préstamo de los bancos para empresas con buenos proyectos. Gambacorta y Shin (2018) brindan una descripción general teórica de este "canal de préstamos bancarios". Argumentan que los factores de oferta también pueden conducir a un aumento de los préstamos no rentables.

Sin embargo, queda un canal alternativo en gran parte inexplorado que se centra en la demanda de dichas pólizas de crédito. Estudios como el de Agarwal et al. (2018) muestran que la propensión de los consumidores a pedir prestado es clave para explicar cuánto crédito adicional genera la economía. Edmans y Gabaix (2016) estudian este creciente flujo de literatura. Sin embargo, la mayor parte de la literatura en esta corriente se centra en la demanda de crédito de los hogares. Hay una escasez de estudios que se centren en el impacto de la demanda empresarial en la generación de crédito en una economía.

Por otro lado, utilizo los dos informes de Greenpeace publicados en 2007 y 2014 con foco en La Manga como noticias de choque inesperadas que advierten de una futura amenaza existencial. Utilizo la futura amenaza de inundación de La Manga por la subida del nivel del mar como la amenaza existencial que advierten los informes de Greenpeace de 2007 y 2014. Me centro en el sector inmobiliario para explorar el impacto de estos informes de Greenpeace.

Existe un debate sobre cómo y cuándo los mercados inmobiliarios captarán la amenaza de un riesgo climático de este tipo en el precio de la vivienda. Por ejemplo, Bernstein et al. (2019) o Giglio et al. (2021) muestran una relación negativa entre los riesgos climáticos y los precios de las propiedades. Por otro lado, Murfin y Spiegel (2020) no encuentran ninguna relación entre el riesgo climático y el precio de la vivienda. Finalmente, Keys y Mulder (2020) muestran una relación positiva entre el riesgo climático y los precios de la vivienda. Sin embargo, la mayor parte de la literatura existente captura el impacto del riesgo climático real (por ejemplo, inundaciones, aumento del nivel del mar o exposición a huracanes) en el mercado inmobiliario. Sin embargo, hay una escasez de artículos que se centren en noticias impactantes que alteren las creencias sobre el aumento del nivel del mar (SLR). Agarwal et al. (2021) es una de las raras excepciones que utilizan choques de información sobre la amenaza futura del aumento del nivel del mar como la causa del cambio en las creencias climáticas. Contribuyo a esta corriente de literatura rara vez explorada al explorar si los impactos de las noticias climáticas pueden afectar el mercado inmobiliario localizado en La Manga.

El primer capítulo explora cómo reacciona el sector empresarial privado ante el gran e inesperado estímulo crediticio Chino de 2008. El objetivo final de cualquier política de expansión crediticia es inducir un mayor endeudamiento por parte de las empresas. Encuentro que las empresas reaccionan de manera diferente cuando se enfrentan a una mayor oferta de crédito. Este capítulo se centra en una fuente importante de esta respuesta heterogénea al shock crediticio positivo de China en 2008, a saber: la estructura de compensación de los ejecutivos. Dado que el gobierno Chino tiene un fuerte control sobre el sector bancario, el gobierno Chino puede obligar a los bancos a aumentar la oferta de crédito. Por lo tanto, la demanda, más que la oferta, impulsa en gran medida los cambios observados en el endeudamiento de las empresas en este estudio. Encuentro que esta política de expansión crediticia China de 2008 motiva a los ejecutivos con salarios variables más altos a pedir prestado más.

El segundo capítulo proporciona un modelo teórico centrado en tres preguntas importantes relacionadas con la estructura de compensación ejecutiva y su impacto en el incentivo del director ejecutivo para pedir más préstamos y la sensibilidad de la empresa al estímulo crediticio Chino de 2008. Los modelos existentes en la literatura han utilizado al menos uno de los tres elementos anteriores como exógeno. Este documento es diferente del resto de la literatura ya que el modelo de este documento utiliza la compensación del director general, el apalancamiento de la empresa y los márgenes de endeudamiento como endógenos.

El modelo muestra que el paquete de compensación óptimo es una combinación de componentes fijos y variables que motivan a un CEO a realizar un esfuerzo costoso y brinda suficiente protección a los intereses financieros propios del CEO. Dado que el apalancamiento de la empresa y el esfuerzo del director general son complementarios del accionista, el paquete de compensación óptimo debe tener un salario total que aumente en el apalancamiento. Este mayor paquete de compensación también puede hacer que estas empresas sean más sensibles a los futuros estímulos políticos. Finalmente, el modelo muestra que las empresas con una alta propiedad ejecutiva pedirán más préstamos en respuesta a una mayor oferta de crédito. Por lo tanto, los hallazgos descubren un canal potencial que puede desempeñar un papel importante en la eficacia de las políticas crediticias.

El tercer capítulo muestra que los precios reaccionan a las noticias impactantes relacionadas con el riesgo climático futuro. Este documento explota los informes de Greenpeace de 2007 y 2014 que afirman la amenaza existencial de La Manga debido al futuro aumento del nivel del mar. Los resultados muestran que el precio medio de transacción en La Manga reacciona negativamente a los informes de Greenpeace con respecto a una serie de grupos de control. Los resultados también indican una tendencia similar para el precio de cotización. Sin embargo, como predice la teoría, los resultados no observan ningún cambio en los mercados de alquiler. Esto sugiere que los mercados están valorando la futura reasignación de población. Además, si bien los efectos de los precios son fuertes y estadísticamente significativos, estos efectos son aún más fuertes para los compradores de viviendas españoles. Los resultados también indican que los compradores siguen comprando propiedades pero a precios más bajos a menos que se refuerce su amenaza de riesgo climático. Estos hallazgos sugieren que los compradores están dispuestos a correr el riesgo del cambio climático comprando propiedades en La Manga pero a un nivel de precio más bajo. Por lo tanto, podemos concluir que, al menos mientras el aumento del nivel del mar es más una amenaza que un peligro real, la mayoría de los efectos se sentirán en los precios. Además, los compradores de viviendas locales, que son conscientes de tales amenazas, incorporarán esta amenaza climática al decidir sus precios de transacción.

En conjunto, los tres capítulos de esta tesis contribuyen a la literatura existente en múltiples frentes. Los primeros dos capítulos de la tesis se enfocan en proponer y brindar apoyo empírico al lado de la "demanda" de las políticas crediticias. Además, el capítulo dos utiliza el concepto novedoso de usar la compensación del director ejecutivo, el apalancamiento de la empresa y los márgenes de endeudamiento como endógenos en un modelo teórico. El tercer capítulo proporciona evidencia empírica a la corriente de literatura poco explorada que se centra en las noticias sobre el cambio climático.

Chapter 1

CREDIT STIMULUS, EXECUTIVE OWNERSHIP AND FIRM LEVERAGE[1]

1.1 Introduction

The Great Recession of 2008 triggered an extraordinarily large and rapid response by monetary authorities world-wide. A key feature of these policies was to provide banks with additional funds at a reduced cost. Agarwal et al. (2018, Page 130) discuss this stimulus policy and note that "one goal was to encourage banks to expand credit to households and firms that would, in turn, increase their borrowing, spending, and investment".

Most of the literature examining the effectiveness of credit policies has focused on the "supply" side frictions that alter banks' willingness to lend. For example, Bebchuk and Goldstein (2011) develop a model in which the banks abstain from lending to firms even when the firms have good projects. Gambacorta and Shin (2018) provide a recent survey of this literature, which is usually known as the "bank lending channel". They argue that poorly capitalized banks have lower loan growth. The supply factors can also lead to an increase in unprofitable lending. Agarwal and Ben-David (2018) document that incentivizing bank loan officers to prospect for new loans results in a significant loan volume increase but the ex-post performance of these loans is worse than other loans.

Our paper takes a different approach. We study the "demand" side of credit policies, which is a relatively unexplored research area. Agarwal et al. (2018) show that consumers' propensity to borrow is key in explaining how much additional credit the economy generates. Their focus is exclusively on households' credit demand. In this paper, we focus on corporate borrowers. We provide evidence that the structure of executive compensation is an important determinant of the transmission of credit policies. In this regard, our results complement the growing literature that links compensation policies and risk-taking. Edmans and Gabaix (2016) survey this growing stream of literature.

Specifically, we examine the evolution of borrowings by Chinese public-listed firms after the announcement of a remarkably large credit stimulus by the government of China in November, 2008.

The 2008 Chinese stimulus provides an interesting natural experiment. The stimulus was exceptionally large and unanticipated (Naughton, 2009 and Deng et al. 2015).[2] Importantly,

[1] The metarials in the chapter are based on joint research work with Sandeep Dahiya, Lei Ge and Pedro Gete. This chapter is published in Management Science, December 2021

[2] Total loan quotas, which are the lending targets that Chinese bank officials are expected to meet, were increased from RMB 4.9 trillion in 2008 to almost RMB 10 trillion in 2009 (Cong et al. 2019). At the same time, the Central Bank dramatically lowered banks' reserve requirements and expanded the money supply.

for the periods that we study (i.e. 2007-2010 as the longer sample period and 2008-2009 as the shorter sample period), the "supply" side problem of credit expansion studied in the bank lending channel literature is not a major factor in China. This is because during the pre-stimulus period, state-controlled banks originated most of the credit in the economy and these banks reacted strongly to the stimulus. Deng et al. (2015) pointed out that Chinese government forced the state-owned banks to lend more and the banks obliged.

The baseline approach we adopt in this study is to estimate an interaction coefficient to measure heterogeneous changes caused by an exogenous shock in the form of a large Chinese credit stimulus in 2008. We compare the pre- and post-stimulus time periods and exploit the cross-sectional differences in the executive ownership levels across firms at the time when the credit stimulus was announced. This allows us to isolate the effect of credit stimulus on leverage choices made by firms with different levels of executive ownership.

The difference between the pre- versus post-stimulus executive ownership is plausibly exogenous. The government's credit push was largely unexpected and there is no reason to believe that firms with higher managerial ownership played any role in inducing the government to launch the credit expansion. We conduct a large number of tests to ensure that.

Furthermore, there is no theoretical reason why the differences in reactions across banks to the credit stimulus could drive our results. Nevertheless, we also perform a series of tests to rule this possibility out.[3]

Our core result is that, following the 2008 credit push, firms whose executives owned a larger fraction of the firm-equity (i.e. stronger pay-for-performance incentives), increase leverage significantly more compared to firms with lower managerial ownership.[4] On average, one standard deviation increase in managerial ownership is associated with two percent higher leverage. Thus, we show that the structure of executive compensation has a significant influence on how firms react to a credit stimulus.

Over our window of analysis and given the large number of fixed effects and controls that we use in our analyses, executive ownership is expected to be unrelated to the factors driving the response to the credit stimulus. We conduct multiple tests to ensure that as well.

First, we conduct a parallel trends analysis. We find that the leverage ratios of high versus low managerial ownership firms do not follow a perfectly linear trend in the pre-stimulus period. However, a sensitivity analysis to check for the validity of parallel trends assumption reveals that we do not have sufficient evidence to reject the parallel trends assumption until a high

[3]The literature is also unaware of any additional policies over our sample period other than the 11th five-year plan for 2006-2010. The impact of this plan was anticipated since it was announced (Purda, 2007).

[4]The fraction of total equity owned by the executives is commonly employed in studies of managerial ownership. For example, Panousi and Papanikolau (2012) use this measure with U.S. data to show that the negative effect of idiosyncratic risk on investment is stronger when risk-averse executives hold a higher fraction of a firm's equity.

level of nonlinearity is introduced in the model. Furthermore, in the post-stimulus period, the executives of firms with higher ownership increase their leverage ratios dramatically compared to the firms with lower executive ownership.

Second, we include industry and industry-year fixed effects in our model specification. We also use a large set of firm level controls in our models. These controls include whether the firm is a state-owned-enterprise, return-on-assets, book-to-market ratios, firm size, concentration of the ownership structure, institutional ownership and share of fixed assets in the total assets of the firm. We estimate the parameters for the baseline model for our focal 2007-2010 sample period. Additionally, we also estimate the parameters for the baseline model for the shorter 2008-2009 period in order to capture the immediate impact of the 2008 credit shock.

We find that, after the 2008 credit shock, firms with high executive ownership levels borrow more than the firms with low levels of executive ownership for our benchmark sample period of 2007-2010 as well as for the shorter 2008-2009 sample period.

Third, we re-analyze our benchmark model using a set of nonlinear model specifications. In the first specification, we create a single dummy variable denoted as $TopQuartile_{2008}$, representing the firms in the top quartile of the executive ownership level in 2008, and include it along with its interaction term with the dummy variable representing the credit shock ($Credit\ Push_t$).

In the second specification, we drop all firms that report executive ownership level of zero. The remaining sub-sample represents almost 50% of the original sample. Within this sub-sample, we create four dummy variables representing executive ownership quartiles, where ExQuartile1 denotes the lowest 25% of executive ownership level and ExQuartile4 denotes the top 25% of executive ownership level. We re-estimate our benchmark model by including these quartile dummies and their interactions with the credit shock dummy given by $Credit\ Push_t$. Even with this model specification, our main results remain robust.

Fourth, we use a dynamic regression model to check the reaction pattern across firms over time to the credit stimulus. In this dynamic specification, we interact the executive ownership level across firms over time with respective year dummies. The results of this dynamic regression model indicate that the parallel trends assumption may not hold true. To overcome this issue, we undertake a sensitivity analysis by introducing nonlinearity in the parallel trends assumption. The relatively large value (with reference to zero that represents the absence of nonlinearity) of the nonlinearity parameter suggest that our main findings hold true even in the presence of nonlinearity in the dynamic model specification.

Fifth, to ensure that any prior bank-borrower relationship is not driving our results, we estimate a model controlling for such relationships. Even with this specification, we observe that high managerial ownership firms opt for higher leverage relative to the low executive ownership firms for both sample periods.

Sixth, we employ a propensity score matching (PSM) methodology. We designate the firms in top quartile of managerial ownership as "treated" group. We match each of these treated firms with another firm that is predicted to have a similar level of managerial ownership but in fact does not have so. This matched set of firms is classified as "control" group. Again, we find that holding all else constant at the sample means, the top quartile firms increase their leverage significantly more.

Additionally, we conduct a host of robustness tests including: a) using time fixed effects; b) a placebo test in which we randomly designate 2011 as the year of credit shock; c) using firm fixed effects; d) testing if our results are driven by a disproportionately large impact of the credit stimulus (i.e. the credit shock) on the state owned enterprises (SOEs); e) measuring if the impact of the credit stimulus on infrastructure firms is driving our results; f) measuring credit demand using an alternate variable (log of debts); g) measuring changes in leverage based on pre-credit push compensation structure, and h) using ratio of value of equity owned by the executives to the cash salary of the top three executives as an alternate measure of managerial pay-for-performance sensitivity.

Taken together, consistent findings across all these tests across both 2007-2010 and 2008-2009 sample periods strongly suggest that the structure of managerial compensation plays a significant role to influence a firm's reaction to a credit expansion.

Our paper links two strands of prior research. First, there is a growing literature that examines the interplay between a firm's pay-for-performance sensitivity of its top executives and its financial policy. Some recent examples include Cheng et al. (2015); Gopalan et al. (2014); Milidonis and Stathopoulos (2014); Panousi and Papanikolau (2012), Gete and Gomez (2015, 2018) and Shue and Townsend (2017).

Second, there is a large literature that studies credit and monetary policies mostly focusing on the credit suppliers (see Ioannidou et al. 2015; Dell'Ariccia et al. 2017 or Gambacorta and Marques-Ibanez, 2011).

To our knowledge, we are the first to study how different corporate borrowers react to a credit stimulus and to show that executive ownership plays a significant role in the post-expansion leverage choice of firms.

In addition, we also contribute to the growing literature on the Chinese corporate sector. The previous studies have focused either on the drivers of executive compensation (Firth et al. 2006; Chen et al. 2012; and Conyon and He, 2011) or on the drivers of the capital structure (Li et al. 2009, and Firth et al. 2008) separately. Although Jiang and Kim (2020) have surveyed the horizontal agency conflict arising from concentrated ownership structure in China; to the best of our knowledge, ours is the first paper to jointly study the compensation structure and firm leverage of Chinese corporations.

Agarwal et al. (2019) and Cong et al. (2019) have also studied the effect of 2008 Chinese credit shock. While Agarwal et al. (2019) focus on examining the impact of a large cut in the benchmark home mortgage rate on the household spending; Cong et al. (2019) focus on credit supply towards state-owned firms. In contrast, we focus on the role of compensation structure as a key factor of shaping the credit demand.

The paper proceeds as follows. Section 1.3 discusses the theoretical motivations that underpin our empirical tests and the main variables used in the study. Section 1.4 describes the 2008 Chinese credit push and credit supply in China. Section 1.5 presents the main empirical analysis. Section 1.6 discusses the propensity score matching that validates the key results. Section 1.7 summarizes many other robustness tests. Section 1.8 concludes. The Appendix describes the variables. An Online Appendix contains supplementary tables and results.

1.2 Introducción

La Gran Recesión de 2008 provocó una respuesta extraordinariamente amplia y rápida por parte de las autoridades monetarias de todo el mundo. Una característica clave de estas políticas fue proporcionar a los bancos fondos adicionales a un costo reducido. Agarwal et al. (2018, página 130) analiza esta política de estímulo y señala que “un objetivo era alentar a los bancos a expandir el crédito a los hogares y las empresas que, a su vez, aumentarían sus préstamos, gastos e inversiones”.

La mayor parte de la literatura que examina la eficacia de las políticas crediticias se ha centrado en las fricciones del lado de la "oferta" que alteran la disposición de los bancos a prestar. Por ejemplo, Bebchuk y Goldstein (2011) desarrollan un modelo en el que los bancos se abstienen de prestar a las empresas incluso cuando las empresas tienen buenos proyectos. Gambacorta y Shin (2018) brindan un estudio reciente de esta literatura, que generalmente se conoce como el “canal de préstamos bancarios”. Argumentan que los bancos mal capitalizados tienen un menor crecimiento de los préstamos. Los factores de oferta también pueden conducir a un aumento de los préstamos no rentables. Agarwal y Ben-David (2018)documentan que incentivar a los oficiales de crédito bancarios a buscar nuevos préstamos da como resultado un aumento significativo del volumen de préstamos, pero el desempeño ex-post de estos préstamos es peor que otros préstamos.

Nuestro artículo tiene un enfoque diferente. Estudiamos el lado de la “demanda” de las políticas crediticias, que es un área de investigación relativamente inexplorada. Agarwal et al. (2018) muestran que la propensión de los consumidores a endeudarse es clave para explicar cuánto crédito adicional genera la economía. Su atención se centra exclusivamente en la demanda de crédito de los hogares. En este documento, nos centramos en los prestatarios corporativos. Proporcionamos evidencia de que la estructura de compensación de los ejecutivos es un determinante importante de la transmisión de las políticas de crédito. En este sentido, nuestros resultados complementan la creciente literatura que vincula las políticas de compensación y la asunción de riesgos. Edmans y Gabaix (2016) estudian este creciente flujo de literatura.

Específicamente, examinamos la evolución de los préstamos de las empresas Chinas que cotizan en bolsa después del anuncio de un estímulo crediticio notablemente grande por parte del gobierno de China en noviembre de 2008.

El estímulo Chino de 2008 proporciona un interesante experimento natural. El estímulo fue excepcionalmente grande e inesperado (Naughton, 2009 and Deng et al. 2015).[5] Es importante destacar que, para los períodos que estudiamos (es decir, 2007-2010 como el período de muestra más largo y 2008-2009 como el período de muestra más corto), el problema del lado de la "oferta" de la expansión del crédito estudiado en la literatura del canal de préstamos bancarios no es un factor importante en China. Esto se debe a que durante el período previo al estímulo, los bancos controlados por el estado originaron la mayor parte del crédito en la economía y estos bancos reaccionaron fuertemente al estímulo. Deng et al. (2015) señalaron que el gobierno Chino obligó a los bancos estatales a prestar más y los bancos accedieron.

El enfoque de referencia que adoptamos en este estudio es estimar un coeficiente de interacción para medir los cambios heterogéneos causados por un shock exógeno en la forma de un gran estímulo crediticio Chino en 2008. Comparamos los períodos de tiempo previos y posteriores al estímulo y explotamos el cruce-diferencias seccionales en los niveles de propiedad ejecutiva entre empresas en el momento en que se anunció el estímulo crediticio. Esto nos permite aislar el efecto del estímulo crediticio en las elecciones de apalancamiento realizadas por empresas con diferentes niveles de propiedad ejecutiva.

La diferencia entre la propiedad ejecutiva antes y después del estímulo es plausiblemente exógena. El impulso crediticio del gobierno fue en gran parte inesperado y no hay razón para creer que las empresas con mayor propiedad gerencial jugaron algún papel en inducir al gobierno a lanzar la expansión crediticia. Realizamos un gran número de pruebas para garantizarlo.

Además, no existe ninguna razón teórica por la que las diferencias en las reacciones de los bancos al estímulo crediticio puedan influir en nuestros resultados. No obstante, también realizamos una serie de pruebas para descartar esta posibilidad.[6]

Nuestro resultado central es que, luego del impulso crediticio de 2008, las empresas cuyos

[5] Las cuotas de préstamos totales, que son los objetivos de préstamos que se espera que cumplan los funcionarios bancarios Chinos, aumentaron de 4,9 billones de RMB en 2008 a casi 10 billones de RMB en 2009 (Cong et al. 2019). Al mismo tiempo, el Banco Central redujo drásticamente los requisitos de reserva de los bancos y amplió la oferta monetaria.

[6] La literatura tampoco tiene conocimiento de ninguna política adicional durante nuestro período de muestra que no sea el undécimo plan quinquenal para 2006-2010. El impacto de este plan se anticipó desde que se anunció (Purda, 2007).

ejecutivos poseían una fracción más grande del capital de la empresa (es decir, incentivos de pago por desempeño más fuertes), aumentan el apalancamiento significativamente más en comparación con las empresas con menor propiedad gerencial.[7]

En promedio, un aumento de una desviación estándar en la propiedad gerencial está asociado con un dos por ciento más de apalancamiento. Por lo tanto, mostramos que la estructura de la compensación ejecutiva tiene una influencia significativa en cómo reaccionan las empresas ante un estímulo crediticio.

Durante nuestra ventana de análisis y dada la gran cantidad de efectos fijos y controles que usamos en nuestros análisis, se espera que la propiedad ejecutiva no esté relacionada con los factores que impulsan la respuesta al estímulo crediticio. Realizamos múltiples pruebas para asegurar eso también.

Primero, llevamos a cabo un análisis de tendencias paralelas. Encontramos que los índices de apalancamiento de las empresas de propiedad gerencial alta versus baja no siguen una tendencia perfectamente lineal en el período previo al estímulo. Sin embargo, un análisis de sensibilidad para verificar la validez del supuesto de tendencias paralelas revela que no tenemos suficiente evidencia para rechazar el supuesto de tendencias paralelas hasta que se introduce un alto nivel de no linealidad en el modelo. Además, en el período posterior al estímulo, los ejecutivos de las empresas con mayor propiedad aumentan drásticamente sus índices de apalancamiento en comparación con las empresas con menor propiedad ejecutiva.

En segundo lugar, incluimos la industria y los efectos fijos de la industria y el año en la especificación de nuestro modelo. También usamos un gran conjunto de controles de nivel firme en nuestros modelos. Estos controles incluyen si la empresa es una empresa de propiedad estatal, el rendimiento de los activos, las relaciones contables a mercado, el tamaño de la empresa, la concentración de la estructura de propiedad, la propiedad institucional y la participación de los activos fijos en los activos totales de la empresa. Estimamos los parámetros para el modelo de referencia para nuestro período de muestra focal 2007-2010. Además, también estimamos los parámetros para el modelo base para el período más corto de 2008-2009 a fin de capturar el impacto inmediato del shock crediticio de 2008.

Encontramos que, después del shock crediticio de 2008, las empresas con altos niveles de propiedad ejecutiva piden prestado más que las empresas con bajos niveles de propiedad ejecutiva para nuestro período de muestra de referencia de 2007-2010, así como para el período de muestra más corto de 2008-2009.

En tercer lugar, volvemos a analizar nuestro modelo de referencia utilizando un conjunto de

[7] La fracción del capital total propiedad de los ejecutivos se emplea comúnmente en estudios de propiedad gerencial. Por ejemplo, Panousi y Papanikolau (2012) usan esta medida con datos de EE. UU. para mostrar que el efecto negativo del riesgo idiosincrático en la inversión es más fuerte cuando los ejecutivos adversos al riesgo mantienen una fracción mayor del capital de una empresa.

especificaciones de modelo no lineal. En la primera especificación, creamos una sola variable ficticia denominada $TopQuartile_{2008}$, que representa a las empresas en el cuartil superior del nivel de propiedad ejecutiva en 2008, y la incluimos junto con su término de interacción con la variable ficticia que representa el shock crediticio ($Credit\ Push_t$).

En la segunda especificación, descartamos todas las empresas que reportan un nivel de propiedad ejecutiva de cero. La submuestra restante representa casi el 50% de la muestra original. Dentro de esta submuestra, creamos cuatro variables ficticias que representan los cuartiles de propiedad ejecutiva, donde ExQuartile1 denota el 25% más bajo del nivel de propiedad ejecutiva y ExQuartile4 denota el 25% superior del nivel de propiedad ejecutiva. Volvemos a estimar nuestro modelo de referencia al incluir estas variables ficticias de cuartil y sus interacciones con la variable ficticia de shock crediticio proporcionada por $Credit\ Push_t$. Incluso con la especificación de este modelo, nuestros principales resultados siguen siendo sólidos.

En cuarto lugar, utilizamos un modelo de regresión dinámica para comprobar el patrón de reacción de las empresas a lo largo del tiempo ante el estímulo crediticio. En esta especificación dinámica, interactuamos con el nivel de propiedad ejecutiva de las empresas a lo largo del tiempo con las respectivas variables ficticias anuales. Los resultados de este modelo de regresión dinámica indican que la suposición de tendencias paralelas puede no ser cierta. Para superar este problema, llevamos a cabo un análisis de sensibilidad introduciendo la no linealidad en el supuesto de tendencias paralelas. El valor relativamente grande (con referencia a cero que representa la ausencia de no linealidad) del parámetro de no linealidad sugiere que nuestros hallazgos principales son válidos incluso en presencia de no linealidad en la especificación del modelo dinámico.

En quinto lugar, para garantizar que ninguna relación anterior entre el banco y el prestatario esté impulsando nuestros resultados, estimamos un modelo que controla dichas relaciones. Incluso con esta especificación, observamos que las empresas de propiedad gerencial alta optan por un mayor apalancamiento en relación con las empresas de propiedad ejecutiva baja para ambos períodos de muestra.

Sexto, empleamos una metodología de emparejamiento de puntuación de propensión (PSM). Designamos a las empresas en el cuartil superior de propiedad gerencial como grupo "tratado". Emparejamos cada una de estas empresas tratadas con otra empresa que se predice que tendrá un nivel similar de propiedad gerencial pero que en realidad no lo tiene. Este conjunto emparejado de empresas se clasifica como grupo de "control". Nuevamente, encontramos que manteniendo todo lo demás constante en las medias de la muestra, las empresas del cuartil superior aumentan su apalancamiento significativamente más.

Además, llevamos a cabo una serie de pruebas de robustez que incluyen: a) el uso de efectos fijos en el tiempo; b) una prueba de placebo en la que designamos aleatoriamente 2011 como el año del shock crediticio; c) utilizando efectos fijos firmes; d) probar si nuestros resultados están impulsados por un impacto desproporcionadamente grande del estímulo crediticio (es decir, el shock crediticio) en las empresas estatales (SOE); e) medir si el impacto del estímulo crediticio en las empresas de infraestructura está impulsando nuestros resultados; f) medir la demanda de crédito utilizando una variable alterna (log de deudas); g) medir los cambios en el apalancamiento con base en la estructura de compensación de empuje previa al crédito, y h) usar la relación entre el valor del capital propiedad de los ejecutivos y el salario en efectivo de los tres principales ejecutivos como una medida alternativa de sensibilidad de pago por desempeño gerencial.

En conjunto, los hallazgos consistentes en todas estas pruebas en los períodos de muestra 2007-2010 y 2008-2009 sugieren fuertemente que la estructura de compensación gerencial juega un papel importante para influir en la reacción de una empresa a una expansión crediticia.

Nuestro artículo vincula dos líneas de investigación previa. En primer lugar, hay una creciente literatura que examina la interacción entre la sensibilidad de pago por desempeño de una empresa de sus altos ejecutivos y su política financiera. Algunos ejemplos recientes incluyen Cheng et al. (2015); Gopalan et al. (2014); Milidonis y Stathopoulos (2014); Panousi y Papanikolau (2012), Gete y Gomez (2015, 2018y Shue y Townsend (2017).

En segundo lugar, hay una gran cantidad de literatura que estudia las políticas crediticias y monetarias, centrándose principalmente en los proveedores de crédito (ver Ioannidou et al. 2015; Dell'Ariccia et al. 2017 o Gambacorta y Marques-Ibanez, 2011).

Hasta donde sabemos, somos los primeros en estudiar cómo reaccionan los diferentes prestatarios corporativos a un estímulo crediticio y en mostrar que la propiedad ejecutiva juega un papel importante en la elección de apalancamiento de las empresas después de la expansión.

Además, también contribuimos a la creciente literatura sobre el sector corporativo Chino. Los estudios anteriores se han centrado en los impulsores de la compensación ejecutiva (Firth et al. 2006; Chen et al. 2012 y Conyon y He, 2011) o sobre los impulsores de la estructura de capital (Li et al. 2009, y Firth et al. 2008) por separado. Aunque Jiang y Kim (2020) han analizado el conflicto de agencia horizontal que surge de la estructura de propiedad concentrada en China; Hasta donde sabemos, el nuestro es el primer artículo que estudia conjuntamente la estructura de compensación y el apalancamiento firme de las corporaciones Chinas.

Agarwal et al. (2019) y Cong et al. (2019) también han estudiado el efecto del shock crediticio Chino de 2008. Mientras que Agarwal et al. (2019) se centra en examinar el impacto de un gran recorte en la tasa hipotecaria de referencia sobre el gasto de los hogares; Cong et al. (2019) se centran en la oferta de crédito hacia empresas estatales. Por el contrario, nos centramos en el papel de la estructura de compensación como un factor clave para dar forma a la demanda de crédito.

El documento procede de la siguiente manera. La sección 1.3 analiza las motivaciones teóricas que sustentan nuestras pruebas empíricas y las principales variables utilizadas en el estudio. La Sección 1.4 describe el impulso crediticio y la oferta crediticia de China en 2008. La sección 1.5 presenta el principal análisis empírico. La Sección 1.6 analiza la coincidencia de puntuación de propensión que valida los resultados clave. La Sección 1.7 resume muchas otras pruebas de robustez. La sección 1.8 concluye. El Apéndice describe las variables. Un apéndice en línea contiene tablas y resultados complementarios.

1.3 Theory and main variables

1.3.1 Theory

Dahiya et al. (2018) show the underlying mechanism for a positive relationship between executive incentives and firm leverage. They argue that this positive relationship is due to the fact that equity is a residual claim, while debt is a fixed claim.

Equity payments are used to encourage an executive to take actions realigning her own incentives with the incentives of the firm. A larger variable component implies that the executive compensation has a higher pay-for-performance sensitivity. After accepting the contract, the executive chooses her effort level as well as how much debt to take on. Larger debt expands the scope of the firm and can potentially lead to a larger cash flow.

Dahiya et al. (2018) argue that both leverage and compensation are endogenous. For a shareholder, the firm's leverage and the executive's effort are complements. That is, greater effort makes higher future cash flow more likely, and this allows the firm to sustain a higher level of leverage. This implies that the shareholders of firms desiring a higher level of debt will include a larger variable component in the executive compensation contract to encourage the executive to exert more effort. Thus, the optimal action of shareholders can generate a positive cross-sectional relationship between the level of leverage and the degree of pay-for-performance sensitivity (i.e. variable component) of executive compensation.

Since the government credit subsidy increases the value of the borrowing firm, its executive will borrow more if she is promised a larger share of the firm. In addition, after the credit stimulus, variable compensation increases as shareholders want to encourage their executives to borrow. Such an action on behalf of the shareholders will allow executives with equity stakes reap the benefits of increase in firm value from subsidized funding by leveraging more following a credit stimulus (Dahiya et al. 2018).

1.3.2 Main variables

We utilize two main sets of data: the China Stock Market & Accounting Research (CSMAR) dataset and the Wind Financial database. CSMAR is the leading database for accounting and market information about Chinese corporations. It has been used in a number of recent research studies such as Conyon and He (2011), Giannetti et al. (2015), Jiang and Kim (2015), Liao et al. (2014), and Piotroski and Zhang (2014). Wind is the other major data source for Chinese firms and has been used by Li et al. (2011) and Chen et al. (2012).

Following the capital structure literature, we exclude financial firms given their significant differences in leverage and regulation relative to the other industries.[8] We also restrict our sampling universe to those firms which were publicly-listed before 2008 and had a book value of equity greater than zero.

For the executive ownership of the firm, we create a continuous measure similar to the insider-holding variable used for U.S. based studies like Panousi and Papanikolau (2012). This measure takes the total number of shares owned by the firm's executives and divides it by the number of shares outstanding, we denote it as *ExecutiveOwnership*.

Our other main variable of interest is the firm's leverage level. Following the commonly used methodology outlined in Berger et al. (1997), we measure the level of leverage at the end of the fiscal year using two continuous variables:

$$BookLeverage = \frac{TotalDebt(BookValue)}{TotalAsset(BookValue)} \tag{1.1}$$

and

$$MarketLeverage = \frac{TotalDebt(BookValue)}{TotalDebt(BookValue) + Equity(MarketValue)} \tag{1.2}$$

We include detailed definitions of all these variables in the Appendix.

There is one specific firm characteristic that is unique to our sample which merits more discussion. Unlike most developed economies, a large fraction of publicly listed firms in China are state-owned enterprises (SOEs) that undertook the share issue privatization process. Many empirical studies focusing on China explicitly acknowledge this by including a control for SOEs (see for example Piotroski and Zhang, 2014). We follow their approach and in all our regression tests we include a dummy variable that equals one if the firm is a SOE and zero otherwise. In our robustness tests, we re-estimate our empirical models on a sub-sample that excludes the SOEs.

Table 1.1 summarizes the key variables in our main sample which is a four year (2007-2010) panel of publicly-listed Chinese firms. We have data on 1,547 firms. We start by reporting the leverage and compensation proxies which are at the center of our empirical analysis. The average book leverage is 0.50, implying that roughly half the book value of total assets is

[8] See, for example, Garvey and Hanka (1999), Malmendier et al. (2011) or Lemmon et al. (2008).

accounted for by debt. For comparison, Giannetti et al. (2015) also report an average leverage ratio of 0.50 for their sample of Chinese firms over the 1999-2009 sample period. Piotroski and Zhang (2014) report a similar level (0.52) for the sample period 2005-2007.

The average market leverage ratio for our sample is 0.26, which is much lower than the book leverage. While book leverage and market leverage of a firm tend to follow each other closely under normal circumstances (Ferris et al. 2018), they dramatically diverge under large fluctuations of stock prices (Welch, 2004). During our sample period, we observe such a large fluctuation in the Shanghai Stock Exchange Composite Index, which closed at 5,272 at the start of 2008. However, by end of the year in December 2008, the index had dropped to 1,821 implying a loss of nearly two-third of the market value. The following year saw an equally dramatic bounce back with the index climbing to 3,277 implying an increase in valuation of almost 77%. These large fluctuations in market valuations account for the observed large differences in book and market leverages in our focal sample period of 2007-2010.

The average executive ownership in our sample is approximately 2% which is similar to the middle quintile insider holding of 1.01% that Panousi and Papanikolau (2012) report for their sample of U.S. firms.

Panel B of Table 1.1 reports the descriptive statistics of the control variables that we use in our regressions. These are broadly consistent with existing studies of Chinese corporations (see Chen et al. 2012 and Liao et al. 2014). SOEs makeup roughly half of our firm-year observations.

Insert Table 1.1 about here

1.4 The 2008 stimulus and credit supply in China

Given the size of the recession caused by the 2008 financial crisis, the Chinese State Council announced a massive fiscal and monetary stimulus package on November 9, 2008. The monetary stimulus was aimed primarily at enhancing bank lending by increasing the lending quotas for banks, reducing the reserve ratio and cutting the base lending rate (Deng et al. 2015; Ouyang and Peng 2015 and Cong et al. 2019). It was an unexpected and remarkably large shock to the credit supply that we illustrate in Figure 1.1, in which we plot the ratio of credit to GDP for several years before and after the 2008 stimulus (dashed line). As can be seen in the figure, this ratio is quite stable at around 150% up to December of 2008. However, in 2009 the ratio shot up to almost 182% and remains in the same level in 2010. This represents an increase of over 20% in a single year from a fairly stable baseline. The solid line plots the ratio of bank loans to GDP over the same period and shows that bulk of the growth in credit was driven largely by growth in bank loans. This ratio grows from 100% in 2008 to 122% in 2009.

Insert Figure 1.1 about here

Given this sharp discontinuity in 2008, for all of our empirical tests, we provide results for our main four year sample period (2007-2010) along with the shorter sample period of 2008-2009. The shorter sample period captures the baseline leverage and compensation structure in 2008 just before the credit push, and 2009, which incorporates the change in these variables in the immediate aftermath of the large credit expansion. We also examined if the composition of financing sources changed significantly after the credit supply announcement. In 2008, banks account for 73% of all new loans. This ratio also remains essentially unchanged at 75.6% in 2009. Thus, at least over this two year period, there is no significant change in the structure of corporate bank loan market.

Figure 1.2 shows that all banks followed the mandate of the state government to try to lend more. It plots the ratio of bank loans to GDP for two types of banks in China. The solid line represents that total bank loans to GDP for all banks that are directly under state control. The dashed line plots the same ratio for 16 of the largest banks that are indirectly controlled by the government. Together, these two groups account for most of the bank lending in China. Comparing this ratio from the end of 2008 (when the credit shock occurred) to the end of 2010 shows that both groups increased their lending sharply and in a remarkably similar fashion. The stock of bank-loans-to-GDP ratio for the directly controlled banks grows by 20% and this number for the top 16 indirectly controlled banks grows by 25%. Thus, heterogeneity across banks is unlikely to be a major driver of variation in corporate borrowing.

Insert Figure 1.2 about here

Figure 1.3 plots the policy rate in China and the average borrowing cost for the firms in our sample of publicly-listed Chinese firms. The borrowing cost for an individual firm is the ratio of reported interest expenses to the total reported debt for the year. The figure shows that both the policy rate and the average borrowing costs decreased sharply after the 2008 credit push.[9]

Insert Figure 1.3 about here

The top graph of Figure 1.4 provides visual evidence that the 2008 credit stimulus led to a significant drop in borrowing costs for Chinese firms regardless of their level of leverage from 2007 to 2010. This graph illustrates the cost of borrowing for the period before and after the credit push. It is a binned scatterplot. We rank all firms according to their book leverage as reported at the end of 2008 and divide them into 20 bins of roughly 70 firms each. Thus, each bin can be viewed as an equally-weighted portfolio of firms that have similar book leverage

[9]Section C of the online appendix provides a formal test of this figure.

levels. We construct a scatterplot of the average borrowing costs for each bin (y-axis) and the average book leverage (the x-axis). The solid black dots represent our calculations for 2007. The solid black line is the fitted regression for these 20 bins.

Insert Figure 1.4 about here

As expected, the upward sloping regression line implies that the borrowing costs are increasing in leverage. We repeat this exercise for 2010. The gray diamonds represent the relationship between leverage and borrowing cost in 2009. For each of the 20 leverage ratios, the gray diamonds (i.e. 2010) lie below the black dots (2007). The fitted dotted line for 2010 is also below the solid line (2007) and the difference is almost one percentage point in borrowing costs across the entire leverage spectrum.

The bottom graph of Figure 1.4 shows the same analysis but compares 2008 to 2009. Again the figure shows that the firms had consistently higher borrowing costs in 2008 compared to 2009 at every leverage level.

To sum up, the results depicted in these figures show that China's 2008 credit push was large and had a significant and wide-ranging impact on the firms' leverage ratios as it was followed by a large increase in borrowing and a sharp decrease in borrowing costs. Furthermore, there is little evidence to suggest that these changes are driven by heterogeneity across banks as the corporate loan market shows little change in composition and almost all the increase in loans appears to be due to increase in lending by banks.

1.5 Heterogeneous responses to a credit shock

This is our baseline empirical section. We analyze heterogenous responses to the Chinese credit stimulus across firms having different levels of executive ownership. First we check that our identifying parallel trends assumption holds. Then we conduct several analyses to test the robustness of our findings for our baseline sample period (2007-2010) and also for the shorter 2008-2009 sample period.

1.5.1 Parallel trends

Our empirical strategy examines the post-2008 change in leverage for firms with different levels of executive ownership. We employ an approach to capture the heterogeneous responses to a credit supply shock (i.e. Chinese credit stimulus) across our two sub-groups (high versus low executive ownership firms).

A key identifying assumption for us is that in the absence of the credit stimulus, the observed difference in changes in leverage ratios across firms would be zero. This assumption is frequently referred to as "parallel trends assumption". In our setting, the parallel trends assumption implies that leverage ratios of high as well as low executive ownership follow a similar trend in the pre-stimulus period. This identifying assumption allows us to isolate the impact of credit stimulus on leverage choices made by the Chinese firms.

Our results show that firms with high executive ownership increased their leverage significantly more compared to firms with low executive ownership in response to the credit stimulus. Figure 1.5 examines this issue by plotting the leverage ratios for these two groups for several years before and after the 2008 stimulus. First, we first rank all firms based on level of executive ownership as estimated at the end of 2008. We denote all firms in which the executives own less than the median level of executive ownership as "Low Ownership" firms, while all firms above the median are denoted as "High Ownership". Next, we calculate the average book leverage for both these groups annually for the period 2005 to 2012. Finally, in Figure 1.5 we plot the evolution of the leverage ratio for these two groups over this eight-year period. The solid black line represents the leverage ratio for the low ownership group while the dashed line represents the leverage ratio of the high ownership group.

Insert Figure 1.5 about here

Figure 1.5 shows that for the four-year period leading up to 2008, the leverage ratios for both groups appear to be following a similar trend. The leverage of low executive ownership firms is always larger than that of the high executive ownership firms. However, immediately after the 2008 credit stimulus, the leverage ratio of the high ownership group increases sharply and within two years it becomes larger than that of the low ownership group. This sharp break in the leverage ratio pattern for high executive ownership firms in 2008 motivates the empirical strategy employed in this study.

For additional robustness test of the parallel trends assumption, we undertook a dynamic regression model analysis. We provide a detailed discussion about the same in Section 1.4.4.

1.5.2 Baseline results

We estimate how the change in a firm's leverage after the credit expansion is related to the ownership by its executives. Our empirical strategy consists of estimating panel regression models where the dependent variable (i.e. leverage ratio) is either book leverage or market leverage as defined in Equations (1.1) and (1.2) respectively. The benchmark model that we estimate is:

$$
\begin{aligned}
Leverage\,Ratio_{it} = &\beta_0 + \beta_1 ExecutiveOwnership_{it} + \beta_2 Credit\,Push_t + \\
&+ \beta_3 ExecutiveOwnership_{it} \times Credit\,Push_t + \\
&+ \sum_k \beta_k Controls_{itk} + \alpha_{jt} + u_{it}.
\end{aligned} \qquad 1.3
$$

where i indexes firms, t indexes years, and j indexes industry. $Leverage\,Ratio_{it}$ is the leverage ratio (book leverage or market leverage) of the firm i at the end of year t; $ExecutiveOwnership_{it}$ is the fraction of total shares owned by the top executives of firm i at the end of year t and $Credit\,Push_t$ is a dummy variable that equals one if the observation occurs after 2008 and zero otherwise.[10] Controls are characteristics of firm i at time t. We control for several variables commonly employed in the literature to explain leverage and compensation structure such as firm's operating performance (return-on-assets), growth opportunities (book-to-market ratio), firm's size (natural log of sales), concentration of the ownership structure, institutional ownership and asset composition (ratio of fixed assets to total assets). We also include a dummy variable that equals one for firms in which the government is the largest shareholder and zero otherwise. α_{jt} is a set of industry j and year t fixed effects. We also adjust the standard errors by clustering at the individual firm level.

The main variable of interest is the interaction term ($ExecutiveOwnership_{it} \times Credit\,Push_t$) as it allows us to estimate how the effect of the credit push translates into leverage choices across firms with varying level of executive ownership. Specifically, we are interested in the size and significance of coefficient β_3 which captures the average change in leverage from 2007 to 2010 in the long term and from 2008 to 2009 in the short term for firms with varying levels of executive ownership.

Insert Table 1.2 about here

Table 1.2 describes the results of our baseline regression. Panel A reports the estimates based on book leverage as the dependent variable for the longer sample period (2007-2010) while Panel B presents the estimation results based on the shorter sample period (2008-2009). The estimates based on market leverage as the dependent variable for both sample periods are given in Table 1.A6 of the Online Appendix.[11]

[10] This definition is also used by Panousi and Papanikolaou (2012) who use executive ownership as the proxy for the pay-performance sensitivity.

[11] To conserve space, we only report the results using book leverage as the dependent variable (for both the 2007-2010 and 2008-2009 sample periods). The results using market leverage as the dependent variable are

In column 1 of Panel A we present the results of our simplest specification where we control for the firm characteristics but do not include any fixed effects. The coefficient for $ExecutiveOwnership_{it} \times Credit\,Push_t$ (β_3) is 0.160 and is significant at one percent level. This implies that higher ownership by the executives is significantly more likely to be associated with a larger increase in debt following a government-initiated credit expansion. Thus, a one standard deviation increase in executive ownership corresponds to an increase of 0.011 in the absolute level of book leverage (0.160×0.07). Since the sample average of book leverage is 0.5, this is an economically significant increase of almost two percent. This increase in book leverage is in addition to the predicted increase of 0.01 in book leverage for all firms after the credit expansion (based on the coefficient of 0.01 for $Credit\ Push_t$).

The coefficient for $ExecutiveOwnership_{it}$ (β_1) is negative and significant at the one percent level. This result is consistent with the argument that the risk-averse executives with a higher level of stock-holding will tend to choose lower levels of debt as their compensation is more exposed to the default of the firm. Huang et al. (2006) also report similar findings using data on Chinese firms from 1994 to 2003. This negative relation is also consistent with the results from other studies using U.S. data (for example, Carlson and Lazrak, 2010; Morellec et al. 2012; and Glover and Levine, 2015).

Thus, holding all else equal, higher ownership by a firm's executives is associated with lower book leverage.

While column 1 reports the results after controlling for the observable firm characteristics, there may be unobservable industry characteristics (both time-invariant and time-variant) that can bias the coefficient estimates. In columns 2 through 3, we re-estimate our benchmark regression specification by introducing an increasingly restrictive set of fixed effects.

In column 2, we include industry fixed effects to control for any time-invariant unobserved differences across different industries. In column 3 we replace the industry fixed effects by industry-time fixed effects. This specification allows us to control for time-varying industry level unobserved heterogeneity.

These specifications provide a strong control for any omitted variables bias in our estimations. Examining the coefficients for $ExecutiveOwnership_{it} \times CreditPush_t$ shows that both size and significance remains essentially unchanged when we introduce industry or industry-year fixed effects (columns 2 and 3).

We report the results of same specification using a shorter sample period of 2008-2009 in Panel B. The shorter sample period offers two advantages. First, the assumption of leverage being a good proxy for stimulus-induced debt growth is more likely to hold in the short-term

reported in the Online Appendix of the paper. We also provide the results of our benchmark model for a seven year sample period (2006-2012) in Table 1.A28 of the Online Appendix. Although weaker, the results using this longer sample period still provides support to our original findings.

rather than in the longer period. This is due to the fact that over an extended period, a firm may issue additional equity as well as additional debt which may influence the leverage ratio. Second, both leverage and executive ownership are endogenous in the long term. These issues are less problematic for a shorter sample period and may allow a sharper identification of the effects of an exogenous shock such as the credit stimulus that we study in our paper. Panel B shows that the coefficient estimates are stronger for the shorter period and provides additional support for the findings reported in Panel A.

We repeat the analysis outlined above using market leverage instead of book leverage as the dependent variable in Equation 1.3. The results are described in Table 1.A6 of the Online Appendix and these results closely mirror the results reported in Table 1.2.[12]

The coefficients of the interaction term $ExecutiveOwnership_{it} \times CreditPush_t$ (β_3) are significantly positive for both book leverage ratio and for market leverage for our focal sample period of 2007-2010 as well as for the shorter 2008-2009 period. Thus, an increase in executive ownership (and the resulting increase in pay-for-performance sensitivity of compensation) for a risk-averse CEO will induce her to reduce leverage, while an increase in subsidized credit via a monetary stimulus will induce her to increase leverage.

Taken together, the results reported in Panel A (for 2007-2010) and Panel B (for 2008-2009) of Table 1.2 and of Table 1.A6 provide strong evidence that high ownership by executives is associated with lower debt levels. However, a government-sponsored credit stimulus creates significantly more incentive for managers with larger ownership to take on greater debt.

1.5.3 Non-linear specifications

Next, we revisit our baseline results but with two non-linear model specifications. First, we create a single dummy variable denoted as $TopQuartile_{2008}$, representing firms in the top quartile of the executive ownership level during 2008 and estimate the following specification:

$$\begin{aligned} Leverage\,Ratio_{it} = {} & \beta_0 + \beta_1 Credit\,Push_t + \beta_2 Top\,Quartile_{2008} + \\ & + \beta_3 Top\,Quartile_{2008} \times Credit\,Push_t + \\ & + \sum_k \beta_k Controls_{itk} + \alpha_{jt} + u_{it}. \end{aligned} \quad 1.4$$

The results for book leverage, reported in Table 1.3 show that the interaction term is positive

[12] The coefficient for $CreditPush_t$ is negative when using market leverage as the dependent variable, implying a decrease in market leverage from 2007 to 2010. This finding is driven largely by the remarkable recovery of the stock prices by the end of 2009 from the extremely low levels at the end of 2008 (see Section 1.2.2 for a detailed discussion). Since our market leverage ratio is calculated at the end of 2007 till the end of 2010, the increase in stock prices in 2009 increases the denominator in Equation 1.2 leading to a mechanically lower level of market leverage following the credit push.

and significant for both the longer sample period (Panel A) and for the shorter sample period (Panel B). Repeating this analysis using market leverage as the dependent variable period produces similar results (see Table 1.A7 of the Online Appendix).

The results show that the firms with high levels of executive ownership (i.e. in the top quartile of executive ownership level) are likely to increase their leverage more in the post credit stimulus period relative to the other firms. This result is consistent with our findings from Section 1.4.2.

Insert Table 1.3 about here

In the second non-linear specification, we drop all firms that report executive ownership level of zero. The remaining sub-sample represents almost 50% of the original sample. Within this sub-sample, we create four dummy variables representing executive ownership quartiles, where $ExQuartile_1$ denotes the lowest 25% and $ExQuartile_4$ denotes the top 25% executive ownership level. We use $ExQuartile_4$ as the reference group and estimate:

$$\begin{aligned} Leverage\,Ratio_{it} = \beta_0 + \sum_{n=1}^{3} \beta_n (ExQuartile_n)_{2008} + \beta_4 Credit\,Push_t + \\ + \beta_5 (ExQuartile_3)_{2008} \times Credit\,Push_t + \\ + \beta_6 (ExQuartile_2)_{2008} \times Credit\,Push_t + \\ + \beta_7 (ExQuartile_1)_{2008} \times Credit\,Push_t + \\ + \sum_k \beta_k Controls_{itk} + \alpha_{jt} + u_{it}. \end{aligned} \quad 1.5$$

The results for book leverage are reported in Table 1.4, Panel A for 2007-2010 and Panel B for 2008-2009. Figures 1.A1 to 1.A4 report the coefficients for both book and market leverage. The results basically show a monotonic relationship that supports the benchmark results.[13]

Insert Table 1.4 about here

1.5.4 Dynamic regression

We also estimate a dynamic regression model by replacing the interaction term $Executive\,Ownership_{it} \times Credit\,Push_t$ with the set of interaction terms i.e. $Executive\,Ownership_{im} \times Year_m$ for the

[13] Using market leverage as the dependent variable also provides similar results (see Table 1.A8 of the Online Appendix).

period 2006-2012 with 2008 as the omitted year. Specifically we estimate the following model:

$$
\begin{aligned}
Leverage\,Ratio_{it} = \beta_0 + \beta_1 Executive\,Ownership_{it} + \sum_{m=2006}^{2012} \beta_m Year_m + \\
+ \sum_{m=2006}^{2012} \beta_{interact,m} Executive\,Ownership_{im} \times Year_m + \\
+ \sum_k \beta_k Controls_{itk} + \alpha_{jt} + u_{it}. \qquad 1.6
\end{aligned}
$$

The coefficients for individual interaction terms will allow us to see for how long the impact of 2008 credit push lasts. We report the results in Table 1.5 (for book leverage) and in Table 1.A9 of the Online Appendix (for market leverage) and find that the interaction coefficient is positive and significant for 2009 and 2010 at one percent level for both book leverage and for market leverage. Thus, compared to 2008 (our omitted year), a larger executive ownership leads to greater leverage levels in the post credit push period for up to two years. However, this effect becomes statistically insignificant after 2010.

Insert Table 1.5 about here

In some of the specifications reported in Table 1.5, the coefficient of the interaction term $Executive\,Ownership_{i,2007} \times Year_{2007}$ is significant. This suggests that parallel trends assumption of a traditional Difference in Difference (DiD) setting may not hold. While our empirical approach is not a classic DiD, we address this issue by following the sensitivity analysis approach suggested by Rambhachan and Roth (2019). We describe the results of this sensitivity analysis in Section 1.6.8. Broadly, the sensitivity analysis suggests that our results are robust to the presence of nonlinearity in the pre-stimulus period.

1.5.5 Demand side interpretation of results

To confirm that our results capture the effects of structure of executive ownership on credit demand, we did two other tests. First, we showed that there are no meaningful differences in types of loans taken by low and high executive ownership firms. We use four loan characteristics that are reported for all loans in the CSMAR-BLCLC dataset, namely: the frequency of borrowing, the size of the loan, the collateral status, and the lender identity to make this comparison. We find that the loan characteristics are largely similar for high and low executive ownership firms. Section B of the Online Appendix contains the details of the same.

Second, to rule out any bank specific supply bias, we looked at bank-borrower relationship as discussed below. We estimate the following modified version of our baseline specification:

$$
\begin{aligned}
Leverage\,Ratio_{it} = {} & \beta_0 + \beta_1 ExecutiveOwnership_{it} + \beta_2 Credit\,Push_t + \\
& + \beta_3 ExecutiveOwnership_{\,it} \times Credit\,Push_t + \\
& + \sum_b \beta_b Bank_{ib} + \sum_k \beta_k Controls_{itk} + \alpha_{jt} + u_{it}.
\end{aligned} \qquad 1.7
$$

The key modification is the inclusion of a number of dummy variables for the past bank-borrower relationship. Specifically we employ a separate CSMAR dataset called the CSMAR–Bank Loans of Chinese Listed Companies (CSMAR-BLCLC) dataset, which includes the details of the new bank-firm loan data.

Each observation in this data is a unique bank-firm loan transaction. We merge the data on all new loans originated during the 2006-2008 period with our original sample. We only retain a firm from our original sample if we can identify it in the CSMAR-BLCLC dataset. This reduces our sample of observations from almost 6,000 to 2,473 for the long sample period and from almost 3,000 to 1,256 for the shorter sample period. However, these reduced samples allow us to control for pre-existing banking relationships. Specifically, this allows us to create a dummy variable $Bank_{ib}$ which equals one if firm i had borrowed at least once from bank b in the pre-credit push period (2006-2008) and zero otherwise. Cong et al. (2019) state that 95% of new loans to Chinese firms are originated by banks with which the borrower has a pre-existing credit relationship. Thus, by including a dummy variable that captures existing lending relationships, we are able to control for any bank-specific heterogeneity.

To keep the number of indicator variables tractable we focus on the 20 largest commercial banks and the three policy banks in China.[14] All the other remaining banks are grouped in a single category. We estimate the specification outlined in Equation 1.7 and report the results in Table 1.6 (for book leverage) and in Table 1.A10 of the Online Appendix (for market leverage). The coefficients for the interaction term $ExecutiveOwnership_{it} \times CreditPush_t$ for book leverage are positive and significant at five percent (for the 2007-2010 sample period) and at one percent level (for the 2008-2009 sample period). However, when using market leverage, the coefficient of the interaction term becomes insignificant for the 2007-2010 period while remaining significant at 1% level for the 2008-2009 period. Therefore, the estimated coefficients, after controlling for prior banking relationship, have quite similar tendencies to those estimated for the baseline specification reported in Table 1.2.

Insert Table 1.6 about here

[14] The three policy banks are Agricultural Development Bank of China (ADBC), China Development Bank (CDB) and the Export-Import Bank of China (Chexim).

Additionally, to explore if the characterization of bank-firm relationship has changed over time, we compare the bank-firm relationships between the pre-credit push period (2006 to 2008) and the post-credit push period (2009 to 2011). We compare the relationship between two sets of firms: a) zero and non-zero executive ownership firms and b) top-quartile executive ownership firms and others. In both cases, the bank-firm relationships remain stable. We provide a detailed discussion on this in Section D of the Online Appendix.

1.6 Propensity score matching

Our results so far have examined a firm's willingness to borrow based on different levels of managerial ownership. In this section we use an alternative approach that addresses concerns that firms with high managerial ownership may differ systematically from firms with low managerial ownership. We compare the leverage choices made by high managerial ownership firms (the treatment group) to the borrowing decisions of a propensity-score-matched sample of low managerial ownership firms (the control group).

The key idea underlying the propensity score matching (PSM) methodology is to create a control group of firms who are similar to the treated firms when compared on several pre-treatment observable characteristics. For our setting, the treated firms are those with high levels of executive ownership. Ideally we would like to compare the response to credit stimulus of this group to the response of an ex-ante similar control group that did not have high managerial ownership level. For the creation of this control group, we employ the nearest neighbor matching of propensity scores, developed by Rosenbaum and Rubin (1983). A number of recent papers, like Michaely and Roberts (2011), Dahiya et al. (2017) and D'Acunto and Rossi (2017), have used this PSM methodology.

We start the matching process by creating the treatment group based on executive ownership at the end of 2008. All firms with ownership levels in the top quartile in 2008 are assigned to the high ownership (treated) group. Specifically, we create a dummy variable $Top\,Quartile$ which equals one if the firm ranks in the top 25% firms based on the executive ownership in 2008 and zero otherwise.

In the second step, we estimate a probit regression model using the $Top\,Quartile$ as the dependent variable and a large set of observable firm characteristics which include all firm-level control variables from the benchmark regression model (Equation 1.3) and additional controls: CEO turnover, whether the CEO and the Chairman of the board is the same person, whether the firm has a compensation committee, the size of the board and the proportion of independent directors in the board. The choice of these additional control variables for the executive ownership is motivated by their use in prior studies of the determinant of incentive pay for the managers (Bettis et al. 2010; Dittmann et al. 2010; Kato et al. 2005; and Bertrand

and Mullainathan, 2001).

The probit model is estimated over the entire cross-section of firms in our sample. This estimation allows us to calculate the predicted probability of being a top quartile executive ownership firm in 2008. We hope to find a matching firm for each top-quartile executive ownership firm based on predicted probability (propensity score). This matched firm will be statistically indistinguishable from the treatment firm based on observable characteristics but will not have a high executive ownership. We employ a one-to-one matching process as outlined by D'Acunto and Rossi (2017).

In the next step, we use the predicted probabilities (i.e. propensity scores) to match each of the high managerial ownership firms to the nearest neighbor from the control group. We employ a one-to-one match without replacement procedure. After the matching process, each firm in the treatment group (top 25% executive ownership) is paired with a firm from the control group that has the closest propensity score. To ensure that our matching procedure creates similar firms in each pair, we follow the process outlined by D'Acunto and Rossi (2017).

We calculate the difference in the propensity score for each matched pair. If the propensity score difference between the matched firms is larger than one quarter of the standard deviation of the executive ownership in our sample, we exclude that pair from our analysis. We also exclude all matched pairs that are not in the common support (whose propensity score is higher than the maximum or less than the minimum propensity score of the controls of our sample).

After applying these exclusions we are left with a final sample of 303 treated and 303 control firms for our PSM tests. The t-test for difference in observable firm characteristics is insignificant for all sixteen attributes (Table 1.A11 of the Online Appendix). These results provide strong evidence that our matching process yields firm pairs that are statistically indistinguishable across the two groups.

We use the propensity score matched sample to estimate the following regression:

$$\begin{aligned} Leverage\,Ratio_{it} = {} & \beta_0 + \beta_1 Top\,Quartile_{\,2008} + \beta_2 Credit\,Push_t + \\ & + \beta_3 Top\,Quartile_{\,2008} \times Credit\,Push_t + \\ & + \sum_k \beta_k Controls_{itk} + \alpha_{jt} + u_{it}. \end{aligned} \tag{1.8}$$

The model described above is similar to Equation 1.4 with one modification. We use the propensity score matched sample instead of the total sample. Again the main coefficient of interest is β_3 which is roughly the average change in leverage from pre-credit push year (2008) to the post credit push year(s) (2009 for the short sample and 2009-2010 for the long sample) for the treatment group (top quartile ownership) minus the same change in leverage for the control group.

The results from estimating Equation 1.8 are presented in Table 1.7 for book leverage and in Table 1.A12 of the Online Appendix for market leverage. Panel A of Table 1.7 provides the results from the longer sample period. The first column is the baseline specification that includes the firm characteristics as control variables but does not include fixed effects. The coefficient β_3 for the interaction term is 0.021 and is significant at the five percent level. It implies that if the firm is in the top quartile of executive ownership in 2008, on average, it increases book leverage by 0.021 more compared to a similar firm (based on observable characteristics) that was not in the top quartile of managerial ownership. It is equivalent to the around 4.2% (0.021 divided by the sample mean book leverage of 0.50) increase in book leverage for firms with top-quartile executive ownership. In columns 2 and 3 of Panel A, we add the industry fixed effect and industry-by-year fixed effects respectively. Both the size and the significance of the coefficient β_3 remains essentially unchanged. This result is quite similar to the result for the shorter sample period (see Panel B of Table 1.7). For the shorter sample period of 2008-2009, a top quartile executive ownership firm increased its book leverage by 4.6% (0.023 divided by the sample mean book leverage of 0.50) on average compared to a similar firm (based on observable characteristics) that was not in the top quartile of managerial ownership.

Insert Table 1.7 about here

In Panel A of Table 1.A12 of the Online Appendix, we present the results using the market leverage as the dependent variable in Equation 1.8 for the longer sample period. Column 1 (firm controls included but no fixed effects) shows that the coefficient β_3 of the interaction term $Top\,Quartile_{2008} \times Credit\,Push_t$ is 0.017 and significant at one percent level. This is equivalent to around 6.5% (0.017 divided by the sample mean market leverage of 0.26) increase in market leverage after the credit stimulus for top quartile managerial ownership firms. This result is robust to adding the industry fixed effect (column 2) and the industry-by-year fixed effect (column 3). Furthermore, this result is quite similar to that of the shorter sample period (see Panel B of Table 1.A12) where the market leverage after the credit stimulus for top quartile managerial ownership firms grew by 6.2% (0.019 divided by the sample mean market leverage of 0.30) relative to the firms that were not in the top quartile of managerial ownership.

We provide additional discussion about the Propensity Score Matching approach in Section E of the Online Appendix.

1.7 Robustness tests

In this section we discuss a number of robustness tests to validate our findings.

1.7.1 Time fixed effects

We also estimate our baseline specification using our focal sample period (2007-2010) by including the full set of time fixed effects with 2008 being the omitted year. The new specification is:

$$\begin{aligned} Leverage\,Ratio_{it} = \beta_0 + \beta_1 Executive\,Ownership_{\,it} + \sum_{m=2007}^{2010} \beta_m Year_m + \\ + \beta_3 Executive\,Ownership_{\,it} \times Credit\,Push_t + \\ + \sum_k \beta_k Controls_{itk} + \alpha_{jt} + u_{it}. \end{aligned} \quad 1.9$$

We report the estimation results of the above specification in Table 1.A13. The main variable of interest is β_3, the coefficient for the interaction term $Executive\,Ownership_{it} \times Credit\,Push_t$. In Table 1.A13, we use book leverage as the dependent variable and coefficient for the interaction term is 0.152 in the least restrictive specification (column 1) and 0.139 in the specification with industry (column 2) and industry-year fixed effects (column 3). The coefficient is significant at one percent level in all three specifications. Table 1.A14 reports the results for market leverage and again we find that the coefficients for the interaction term are positive and significant across all specifications.

1.7.2 Placebo test

A possible concern about our findings is the validity of our natural experiment capturing the impact of the 2008 Chinese credit stimulus on credit supply. Figure 1.5 shows a clear discontinuity in firms' leverages (especially for the firms with high executive ownership) around 2008, when the credit stimulus was introduced. To establish a stronger claim of the causal effect of the credit stimulus on firms' leverage, we design a falsification test in which we designate 2012 (for the shorter sample period) and 2012-2014 (for the longer sample period) as placebo "post-credit push" year(s) by assigning a fake credit push at the end of 2011. We rerun all our tests on the 2011-2014 panel data to simulate a four year sample period (to replicate the longer 2007-2010 sample period) around the fake credit stimulus. We also replicate the falsification test on the 2011 and 2012 panel data to simulate a two year sample period (to replicate the shorter 2008-2009 sample period) around the fake credit stimulus. The results of this placebo test for book leverage and for market leverage are presented in Table 1.A15 and in Table 1.A16 of the Online Appendix.

Since there was no policy shift in the placebo period, we expected to see the placebo credit push period of 2012 ($Post2012$) to have no explanatory power. This is indeed what we find. For both book leverage and market leverage, the coefficient for $ExecutiveOwnership_{it} \times Post2012$ remains statistically insignificant for both sample periods.[15]

1.7.3 Firm fixed effects

Our benchmark model specification in Table 1.2 had industry and industry-year fixed effects. However, there may be unobservable firm characteristics (e.g. corporate culture) which may introduce omitted variable bias in our estimated coefficients. Thus, we add firm fixed effects into our benchmark regression model (Equation 1.3). By adding firm fixed effects, we control for all time-invariant firm-specific characteristics, yielding coefficient estimates that are less likely to be contaminated by omitted variable bias.

Table 1.A17 of the Online Appendix reports the results of our panel regression for book leverage that include firm fixed effects. As in the previous table, Panel A describes our estimation results for the 2007-2010 sample period. Column 1 reports the estimation results in which we only include firm-fixed effects (no other firm level controls). This specification assumes that any change in leverage from 2007 to 2010 for a specific firm is entirely due to managerial ownership, the credit push and the interaction of these two factors. The coefficient $ExecutiveOwnership_{it} \times CreditPush_t$ (i.e. β_3) is insignificant for the longer sample period of 2007-2010 (see Panel A). However, the coefficient (β_3) becomes positive and significant at 5% level for book leverage for the shorter sample period (see Panel B). Thus, even for the same firm, an increase in executive-ownership implies a significantly larger increase in leverage following the credit push in the immediate short term but the credit shock loses its effectiveness over time.

In column 2 we include firm controls that we used for estimation of Equation 1.3 in addition to firm fixed effects. Column 3 reports estimation of a model which also includes industry-year fixed effects. Both the size and the significance of the coefficient for $ExecutiveOwnership_{it} \times CreditPush_t$ (β_3) for both sample periods remains largely unchanged to that of column 1.

The results reported in Table 1.A18 of the Online Appendix employ market leverage as the dependent variable. The results are even stronger than the results for book leverage (see Table 1.A17). Although the results in column 1 follows the similar trend as the results given in Table 1.A17, these results change for the longer sample period in columns 2 and 3. In fact, the coefficient for $ExecutiveOwnership_{it} \times CreditPush_t$ (β_3) becomes significant at one percent level for the longer sample period when firm controls (in column 2) and industry-year fixed

[15] The coefficient of the $ExecutiveOwnership_{it}$, however, is still negative for the placebo test. This is consistent with the theoretical predictions of negative relation between executive ownership and leverage during normal times.

effects (in column 3) are added (see Panel A). The estimated values of the β_3 are increasing from 2% to almost 11% from column 1 to column 3 for the longer sample period. For the results using the shorter sample period, the estimated values of the β_3 remain consistently above 0.20 in all specifications (columns 1 to 3) (see Panel B).

1.7.4 Excluding state owned enterprises

Almost half of our sample consists of State Owned Enterprises (SOE). Deng et al. (2015) argue that a significant fraction of the credit push was aimed at pushing state owned banks to lend to state owned enterprises. We control for this issue by following the approach of Piotroski and Zhang (2014). We include an indicator variable for SOEs in all the estimations discussed in Section 1.4. We classify a firm to be a SOE if the government is the largest shareholder. To classify as SOEs, we follow the approach taken by Chen et al. (2012) and Liao et al. (2014). We checked that alternative definitions do not alter the results.

To ensure that our results are not sensitive to the inclusion of SOEs, we re-estimate our benchmark panel regression for sub-samples in which we exclude all SOEs. The results are described in Table 1.A19 and Table 1.A20 of the Online Appendix.

The coefficient for $ExecutiveOwnership_{it} \times CreditPush_t$ continues to be positive and significant for both measures of leverage across both sample periods. The other variables of interest continue to have coefficients that are of same sign and significance as reported in our main results (see Table 1.2). Thus, our main result that heterogeneity in managerial compensation structure is systematically related to changes in firm's leverage, continues to hold for the sample that excludes the SOEs.

1.7.5 Role of infrastructure firms

The Chinese stimulus package was especially targeted to increase investment in infrastructure (Naughton, 2009). We conduct a robustness test to see if our main findings are being driven by borrowing of the infrastructure related firms. We use the granular industry sector classification of CSMAR database to identify industrial sectors that are likely to be infrastructure focused. Specifically, we classify all firms in the following sectors as infrastructure firms: a) air transport, b) civil engineering, c) construction, d) electricity production and distribution, e) road transport, f) water transport, and g) telecommunications, radio and transmission services.

We identify 159 firms in our sample that operate in an infrastructure related sector. We exclude these firms from our sample and re-estimate our base line specification for both book leverage (Table 1.A21 of the Online Appendix) as well as for market leverage (see Table 1.A22 of the Online Appendix). The interaction coefficient remains positive and significant for both book leverage and for market leverage across the two sample periods.

Taken together, our findings suggest that even after excluding firms that are likely to experience a higher impact of the credit shock from our sample, our main findings do not change.

1.7.6 Debt instead of leverage ratio

It is possible that the observed change in leverage measures (book leverage and market leverage) occurred due to a change in the denominator of leverage (level of assets). To ensure that our results are not influenced by such changes in level of assets of a firm, we substituted the leverage ratios by log of total debt as a measure of credit demand in our model specifications. We implement this approach and estimate the following specification:

$$\begin{aligned} Ln(Debt)_{it} = {} & \beta_0 + \beta_1 Executive\,Ownership_{it} + \beta_2 Credit\,Push_t + \\ & + \beta_3 Executive\,Ownership_{it} \times Credit\,Push_t + \\ & + \sum_k \beta_k Controls_{itk} + \alpha_{jt} + u_{it}. \end{aligned} \tag{1.10}$$

The coefficient for the interaction term in column 1 of Panel A of Table 1.A23 of the Online Appendix is 0.703. As the model estimated is a log-linear specification (Equation 1.10), the coefficients are best interpreted as the impact of one standard deviation increase in executive ownership on increase in debt following the credit stimulus. The standard deviation of executive ownership in our sample is 0.07 (Table 1.1). Thus, a one standard deviation increase in executive ownership, holding all else constant, implies an increase of approximately 5% in total debt.[16]

The results for the shorter sample period (2008-2009) are quite similar with the interaction coefficient of 1.017 (as reported in Panel B, Table 1.A23 of the Online Appendix). This implies an increase of almost 7% increase in total debt for one standard deviation increase in executive ownership. Thus, our results show that higher executive ownership is associated with significantly greater increase in total debt in the post-credit push period.

1.7.7 Pre-credit push compensation

A possible concern is that the firms can react rapidly by adjusting the compensation of their executives in response to the credit stimulus. This concern is unlikely to be a critical one because it pushes our tests towards not finding any significant effects. Nevertheless, we re-estimate our baseline specification in which we fix the compensation structure proxies at their 2008 values. Since these contracts were in place before the announcement of the stimulus package, it is reasonable to argue that they were unaffected by the policy shift announced in November of 2008. The results reported in Table 1.A24 and Table 1.A25 of the Online Appendix show that

[16] Obtained by substituting the estimated coefficient value and the value for standard deviation, $exp(0.703 \times 0.07) - 1$.

our original findings remain robust to this alternative specification.

These findings provide additional support to our argument that the effect of the credit shock is more profound for the firms in the top-quartile of executive ownership level.

1.7.8 Sensitivity analysis of dynamic regression model parameters

We implemented the Rambachan and Roth (2019) approach to study the robustness to non-parallel trends of the key estimate of our analysis, that is, the interaction term between executive ownership level and the 2009 year dummy in the regression on firm leverage. We computed optimal fixed length confidence intervals (FLCI-s) of the coefficient in question (that is, the interaction term for 2009 in the dynamic regression model) across a range of nonlinearity parameters (denoted by M). The larger is the value of the nonlinearity parameter (M), the more the estimation allows for failure of the parallel trends assumption.

We focused on book leverage as the dependent variable. Figure 1.A5 of the Online Appendix has the results. The vertical blue line in Figure 1.A5 is the confidence interval for the interaction term for $M = 0$, that is, the case when the parallel trends assumption perfectly holds.[17] The confidence interval for the interaction term on book leverage is positive and significant. Figure 1.A5 of the Online Appendix shows that as we gradually increase the extent of nonlinearity, that is, as M grows, the estimated interaction term remains significantly positive. In other words, the key estimated coefficient of interest of the paper is positive even as we relax the parallel trends assumption (i.e. when, $M > 0$). Thus, the methodology of Rambachan and Roth (2019) provides strong support for our core results as these results are robust to the failures of the parallel trends assumption.

Our empirical approach is not a classical difference-in-difference (DiD). Instead, our empirical tests examine how Chinese firms reacted to a large credit stimulus shock. We find that firms with high executive ownership increase their leverage significantly more compared to firms with low executive ownership in the post-stimulus period. However, unlike a conventional DiD approach, we do not make strong claims of causality. Therefore, the interpretation of our results is less sensitive to failures of the parallel trends assumption that is central to a traditional DiD approach.

1.7.9 Alternate pay-performance sensitivity measure

We use equity-to-salary ratio as a substitute for executive ownership level to measure the executive pay-performance sensitivity and ran our benchmark model. We provide a detailed discussion about the same in Section F of the Online Appendix.

[17] Both FLCI and CI are using 95% confidence level.

1.8 Conclusions

How the private sector reacts to a government-initiated credit stimulus is an important topic for economists as well as for the policy makers. After all, the ultimate goal for expansionary credit policies is to induce greater borrowing by households and corporations. However, when faced with an increased credit supply, not all firms will respond in a similar manner. This paper focuses on one important source of heterogeneous response to positive credit shocks across firms, namely: the compensation structure of the top executives.

We study the 2008 Chinese government's exceptionally large and unanticipated credit expansion. The Chinese setting offers a unique advantage as the Chinese government has almost complete control over the banking sector. This implies that banks had little discretion in not increasing the credit supply. Thus, demand, rather than supply, largely drives the observed changes in firms' borrowing in this study.

When a large, government-subsidized credit expansion is in place, the executives with higher ownership (i.e. higher pay-for-performance sensitivity) will take on more debt. We provided many tests to validate our results.

Nevertheless, this paper can motivate future research on how credit policies may produce different responses across countries, as well as across different industries within a country. For example, it is possible that the credit policies in Japan, and to a certain extent in Europe, may not lead to significantly more borrowing by the corporate sector because executives did not have enough ownership. In this regard, Gorry et al. (2017) show that the structure of executive compensation is sensitive to taxation. Our results indicate that tax incentives to encourage greater managerial equity ownership can create conditions in which firms will be more willing to increase leverage in response to a credit stimulus.

1.9 Conclusiones

La forma en que el sector privado reacciona a un estímulo crediticio iniciado por el gobierno es un tema importante para los economistas, así como para los responsables de la formulación de políticas. Después de todo, el objetivo final de las políticas crediticias expansivas es inducir un mayor endeudamiento de los hogares y las empresas. Sin embargo, ante una mayor oferta de crédito, no todas las empresas responderán de la misma manera. Este documento se centra en una fuente importante de respuesta heterogénea a los choques crediticios positivos entre empresas, a saber: la estructura de compensación de los altos ejecutivos.

Estudiamos la expansión crediticia excepcionalmente grande e imprevista del gobierno Chino en 2008. El entorno Chino ofrece una ventaja única ya que el gobierno Chino tiene un control casi total sobre el sector bancario. Esto implica que los bancos tenían poca discreción para no aumentar la oferta de crédito. Por lo tanto, la demanda, más que la oferta, impulsa en gran medida los cambios observados en el endeudamiento de las empresas en este estudio.

Cuando se lleva a cabo una gran expansión crediticia subsidiada por el gobierno, los ejecutivos con mayor propiedad (es decir, mayor sensibilidad de pago por desempeño) asumirán más deuda. Proporcionamos muchas pruebas para validar nuestros resultados.

Sin embargo, este documento puede motivar futuras investigaciones sobre cómo las políticas crediticias pueden producir diferentes respuestas entre países, así como entre diferentes industrias dentro de un país. Por ejemplo, es posible que las políticas crediticias en Japón, y hasta cierto punto en Europa, no conduzcan a un endeudamiento significativamente mayor por parte del sector corporativo porque los ejecutivos no tenían suficiente propiedad. En este sentido, Gorry et al. (2017) muestran que la estructura de la compensación ejecutiva es sensible a los impuestos. Nuestros resultados indican que los incentivos fiscales para alentar una mayor propiedad de acciones gerenciales pueden crear condiciones en las que las empresas estarán más dispuestas a aumentar el apalancamiento en respuesta a un estímulo crediticio.

Appendix: Variable Definitions

Here we describe the main variables that we use in the paper. We utilize two main datasets: the China Stock Market & Accounting Research (CSMAR) dataset, and the Wind Financial database. All continuous variables are winsorized at the 1% and 99% level.

1. Main variables:

Book value leverage (Book Leverage) is the ratio of total debt to total assets of the firm.

Market value leverage (Market Leverage) is the ratio of total debt to the sum of market value of the firm's equity and total debt.

Percentage of executive stock-holding (Executive Ownership) is the ratio of the shares held by the executives to the total shares of the firm. The executives are the senior executives disclosed in the annual report, including the CEO, the general manager and other senior managers.

Executive equity to cash salary ratio in 2008 (*Equity to* $Salary_{i,2008}$) is the ratio of the market value of shares held by the executives in 2008 to the annual cash compensation for the top three executives in 2008.

Credit Push is a dummy variable equal to one if year $\geq$2009 and zero otherwise.

Post 2012 is an indicator for the placebo test, denoting one if year $\geq$2012 and zero otherwise.

Interest Expense (%) is the firm's ratio of the interest expense to the total debt.

Year$_t$ represents year dummies

ExQuartile$_i$ represents the i-th quartile of executive ownership with ExQuartile_1 being the lowest quartile and ExQuartile_4 being the highest quartile.

Ln(Debt) represents the log of total debts.

2. Control Variables:

Return-on-assets (ROA) is the ratio of operating income of the firm before taxation and interest expense to the total asset of the firm.

Market-to-book ratio (Market Book) is the ratio of the stock market value of the firm to the book value of the firm's total assets.

Asset tangibility of the firm (Asset Tangibility) is the ratio of the fixed assets to the total assets of the firm.

Positive Net Profit is an indicator to show whether the firm's annual net profit after tax and interest expense is positive.

Dividend is a dummy variable equal to one if the firm paid a dividend in that year and zero otherwise.

State-Owned-Enterprises (SOE) is a dummy variable that equals to one if the firm is directly controlled by the government and zero otherwise.

Size of the firm (Size) is the logarithm of the total sales of the firm.

Concentration of the share structure (Stock Holding Concentration) is the sum of squares of the percent of shares of the five largest shareholders.

Institutional percentage of share (Institution Share) is the ratio of shares held by the institutional investors to the total shares of the firm.

Holding by banks (Bank Holding) is an indicator to show whether the stock of the firm is held by Chinese commercial banks.

Holding by foreign investors (Foreign Holding) is an indicator to show whether the stock of the firm is held by foreign investors.

CEO Turnover indicator (CEO Turnover) is an indicator to show whether the firm has CEO turnover during the fiscal year.

CEO Chairman is a dummy variable that equals one if the CEO is also the chairman of the board. It is zero otherwise.

Compensation Committee is a dummy variable that equals one if the firm has a compensation committee. It is zero otherwise.

Board Size is the number of directors on the board of the firm.

Board Independence is the ratio of outside directors to the total number of directors in the board.

Tables

Table 1.1. Summary Statistics

Variable	# Obs.	# Firms	Mean	Median	SD	Min	Max
A. Main Variables							
Book Leverage	5898	1547	0.50	0.51	0.19	0.01	1.00
Market Leverage	5898	1547	0.26	0.22	0.18	0.00	0.97
Executive Ownership	5898	1547	0.02	0.00	0.07	0.00	0.63
Equity-to-Salary	5833	1519	34.30	0.00	130.01	0.00	795.09
Interest Expense (%)	4283	1465	2.70	2.61	1.67	0.00	8.18
B. Control Variables							
ROA (net)	5898	1547	0.06	0.06	0.07	-0.42	0.55
Firm Size	5898	1547	21.09	21.03	1.48	13.40	28.28
Market Book	5898	1547	2.24	1.70	1.85	0.14	15.69
Asset Tangibility	5898	1547	0.28	0.24	0.19	0.00	0.96
Dividend	5898	1547	0.53	1.00	0.50	0.00	1.00
Positive Net Profit	5898	1547	0.90	1.00	0.30	0.00	1.00
SOE	5898	1547	0.52	1.00	0.50	0.00	1.00
Stock Holding Concentration	5898	1547	0.17	0.15	0.12	0.00	0.76
Institution Ownership	5898	1547	0.07	0.03	0.10	0.00	0.74
Bank Holding	5898	1547	0.03	0.00	0.17	0.00	1.00
Foreign Holding	5898	1547	0.06	0.00	0.24	0.00	1.00
CEO Turnover	5898	1547	0.20	0.00	0.40	0.00	1.00
CEO Chairman	5716	1541	0.85	1.00	0.36	0.00	1.00
Compensation Committee	5898	1547	0.83	1.00	0.38	0.00	1.00
Board Size	5803	1546	9.22	9.00	1.91	3.00	18.00
Board Independence	5803	1546	0.36	0.33	0.05	0.09	0.71

Note: This table reports the summary statistics of the 1,547 publicly-listed Chinese firms over 2007-2010. The unit of observation is firm-year. The variables are defined in the Appendix.

Table 1.2. Executive Ownership and Book Leverage

Panel A: 2007-2010

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.160***	0.145***	0.139***
	(0.000)	(0.001)	(0.001)
Executive Ownership$_{it}$	-0.253***	-0.207***	-0.183***
	(0.000)	(0.000)	(0.000)
Credit Push$_t$	0.010***	0.009***	0.052
	(0.002)	(0.003)	(0.271)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	5898	5898	5898
R^2	0.310	0.348	0.364

Panel B: 2008-2009

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.206***	0.185***	0.188***
	(0.000)	(0.000)	(0.000)
Executive Ownership$_{it}$	-0.222***	-0.179***	-0.180***
	(0.000)	(0.001)	(0.001)
Credit Push$_t$	0.061***	0.055***	0.121***
	(0.000)	(0.000)	(0.003)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	3007	3007	3007
R^2	0.354	0.391	0.393

Note: The sample covers 2007-2010 in Panel A and 2008-2009 in Panel B and estimates Equation 1.3 with Book Leverage as the dependent variable. Executive Ownership$_{it}$ is the number of shares owned by the executives divided by shares outstanding. Credit Push$_t$ denotes whether $t \geq 2009$. Controls are: ROA, firm size, market-to-book ratio, assets tangibility, dividend, positive net profit, SOE, ownership concentration, institutional ownership, bank holding and foreign holding. We include industry and industry-year FE. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.3. Top Quartile Executive Ownership and Book Leverage

Panel A: 2007-2010

	(1)	(2)	(3)
$TopQuartile_{2008} \times Credit\ Push_t$	0.028***	0.022***	0.022***
	(0.001)	(0.005)	(0.008)
$TopQuartile_{2008}$	-0.047***	-0.040***	-0.034***
	(0.000)	(0.000)	(0.001)
$Credit\ Push_t$	0.009***	0.008***	0.049
	(0.008)	(0.009)	(0.305)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	5898	5898	5898
R^2	0.309	0.348	0.364

Panel B: 2008-2009

	(1)	(2)	(3)
$TopQuartile_{2008} \times Credit\ Push_t$	0.042***	0.036***	0.037***
	(0.000)	(0.000)	(0.000)
$TopQuartile_{2008}$	-0.047***	-0.040***	-0.041***
	(0.000)	(0.000)	(0.000)
$Credit\ Push_t$	0.058***	0.052***	0.120***
	(0.000)	(0.000)	(0.003)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	3007	3007	3007
R^2	0.354	0.392	0.393

Note: The sample covers 2007-2010 in Panel A and 2008-2009 in Panel B and estimates Equation 1.4 with Book Leverage as the dependent variable. $Credit\ Push_t$ denotes whether t $\geq$ 2009. $TopQuartile_{2008}$ represents a dummy for the firms belonging to the top quartile of the executive ownership level in 2008. The controls are same as in Table 1.2. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.4. Executive Ownership Quartiles and Book Leverage.

Panel A: 2007-2010

	(1)	(2)	(3)
$ExQuartile3_{2008} \times$ Credit $Push_t$	-0.029**	-0.026*	-0.024*
	(0.046)	(0.060)	(0.078)
$ExQuartile2_{2008} \times$ Credit $Push_t$	-0.028**	-0.024*	-0.023*
	(0.040)	(0.067)	(0.077)
$ExQuartile1_{2008} \times$ Credit $Push_t$	-0.032**	-0.027**	-0.028**
	(0.024)	(0.049)	(0.046)
Credit $Push_t$	0.038***	0.032***	0.104
	(0.001)	(0.003)	(0.212)
Firm's Controls	Yes	Yes	Yes
Ownership Quartile Control	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	2933	2933	2933
R^2	0.372	0.428	0.444

Panel B: 2008-2009

	(1)	(2)	(3)
$ExQuartile3_{2008} \times$ Credit $Push_t$	-0.044***	-0.041***	-0.037***
	(0.002)	(0.002)	(0.007)
$ExQuartile2_{2008} \times$ Credit $Push_t$	-0.056***	-0.049***	-0.047***
	(0.000)	(0.000)	(0.001)
$ExQuartile1_{2008} \times$ Credit $Push_t$	-0.060***	-0.054***	-0.051***
	(0.000)	(0.000)	(0.000)
Credit $Push_t$	0.113***	0.099***	0.208***
	(0.000)	(0.000)	(0.000)
Firm's Controls	Yes	Yes	Yes
Ownership Quartile Control	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	1501	1501	1501
R^2	0.416	0.466	0.468

Note: This table estimates Equation 1.5. The sample covers only non-zero executive ownership firms for the 2007-2010 sample period (Panel A) and for the 2008-2009 sample period (in Panel B) with Book Leverage as the dependent variable. Credit $Push_t$ denotes whether $t \geq 2009$. ExQuartile variables are dummies representing the non-zero executive ownership firms belonging to the four quartiles of executive ownership levels in 2008. ExQuartile4 is used as the reference category. The controls are same as in Table 1.2. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.5. Executive Ownership and Book Leverage, 2006-2012.

	(1)	(2)	(3)
Executive Ownership$_{i,2006}$ × Year$_{2006}$	0.082	0.104	0.075
	(0.480)	(0.354)	(0.511)
Executive Ownership$_{i,2007}$ × Year$_{2007}$	0.096**	0.079*	0.073
	(0.046)	(0.097)	(0.135)
Executive Ownership$_{i,2009}$ × Year$_{2009}$	0.189***	0.170***	0.175***
	(0.000)	(0.000)	(0.000)
Executive Ownership$_{i,2010}$ × Year$_{2010}$	0.205***	0.179***	0.167***
	(0.000)	(0.002)	(0.005)
Executive Ownership$_{i,2011}$ × Year$_{2011}$	0.066	0.045	0.056
	(0.343)	(0.503)	(0.394)
Executive Ownership$_{i,2012}$ × Year$_{2012}$	0.073	0.058	0.082
	(0.230)	(0.317)	(0.167)
Executive Ownership$_{it}$	-0.252***	-0.203***	-0.203***
	(0.000)	(0.000)	(0.000)
Firm's Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	10221	10221	10221
R^2	0.319	0.356	0.361

Note: This table estimates Equation 1.6 with Book Leverage as the dependent variable. The sample covers 2006-2012. Variables are defined in the Appendix. The controls and significance levels are same as in Table 1.2. P-values are in parentheses. Standard errors are clustered at the firm level.

Table 1.6. Executive Ownership and Book Leverage: Controlling Bank-Firm Relations

Panel A: 2007-2010

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.173**	0.167**	0.148**
	(0.015)	(0.017)	(0.037)
Executive Ownership$_{it}$	-0.152**	-0.124**	-0.101*
	(0.009)	(0.041)	(0.095)
Credit Push$_t$	0.006	0.006	0.034
	(0.137)	(0.171)	(0.429)
Prior Bank-Borrower Relationship	Yes	Yes	Yes
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	2473	2473	2473
R^2	0.368	0.408	0.422

Panel B: 2008-2009

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.227***	0.219***	0.214***
	(0.003)	(0.004)	(0.006)
Executive Ownership$_{it}$	-0.136**	-0.115*	-0.111*
	(0.027)	(0.064)	(0.077)
Credit Push$_t$	0.048***	0.042***	0.094*
	(0.000)	(0.000)	(0.066)
Prior Bank-Borrower Relationship	Yes	Yes	Yes
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	1256	1256	1256
R^2	0.398	0.429	0.430

Note: This table estimates Equation 1.7 with Book Leverage as the dependent variable and reports the estimation of the benchmark model controlling for the prior bank-borrower relationship for the 2007-2010 (in Panel A) and 2008-2009 (in Panel B) periods. Executive Ownership$_{it}$ is the number of shares owned by the executives divided by shares outstanding. Credit Push$_t$ denotes whether $t \geq 2009$. The prior-bank-borrower relationship is an indicator variable that equals to one if firm i has borrowed from bank b at least once during the 2006-2008 period (i.e. pre-credit push period). We create this variable for the top 20 commercial banks, the 3 policy banks and a single "Other" category for all the remaining banks using the CSMAR-Bank Loans of Chinese Listed Companies (CSMAR-BLCLC) dataset. The controls are same as in Table 1.2. p-values are in parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% level. Standard errors are clustered at the firm level. The variables are defined in the Appendix.

Table 1.7. Executive Ownership and Book Leverage: Propensity Score Matching

Panel A: 2007-2010

	(1)	(2)	(3)
$TopQuartile_{2008} \times Credit\ Push_t$	0.021**	0.020**	0.021**
	(0.010)	(0.018)	(0.011)
$TopQuartile_{2008}$	-0.031***	-0.034***	-0.034***
	(0.008)	(0.003)	(0.003)
$Credit\ Push_t$	-0.005	-0.005	0.009
	(0.436)	(0.382)	(0.816)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	2407	2407	2407
R^2	0.341	0.388	0.406

Panel B: 2008-2009

	(1)	(2)	(3)
$TopQuartile_{2008} \times Credit\ Push_t$	0.023***	0.022***	0.023***
	(0.006)	(0.007)	(0.005)
$TopQuartile_{2008}$	-0.030**	-0.031**	-0.032**
	(0.017)	(0.011)	(0.010)
$Credit\ Push_t$	0.050***	0.043***	0.071***
	(0.000)	(0.000)	(0.002)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	1204	1204	1204
R^2	0.371	0.410	0.412

Note: This table estimates Equation 1.8 with Book Leverage as the dependent variable for 2007-2010 in Panel A and 2008-2009 in Panel B using the 303 firm pairs created on the basis of propensity scores on the 2008 values of the control variables using the nearest neighbor approach. Variables are defined in the Appendix. All 16 firm characteristic variables used as controls in Table 1.2 have been used to calculate the propensity scores. p-values are in parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% level. Standard errors are clustered at the firm level.

Figures

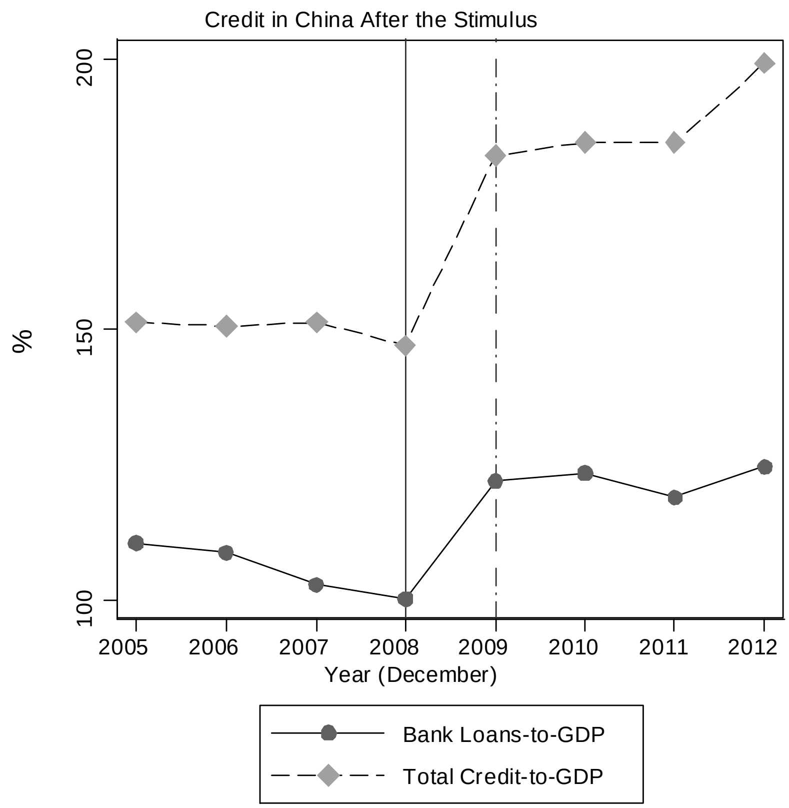


Figure 1.1. The credit-to-GDP ratio vs. the bank loans-to-GDP ratio. The Credit-to-GDP is the ratio of the credit to GDP for the non-financial sector. The Bank Loans-to-GDP is the ratio of the aggregate bank loans to GDP. The vertical solid line is end of 2008, which is when the credit stimulus was announced by the Chinese government. The vertical dashed-line is the end of 2009, one year after the credit push.

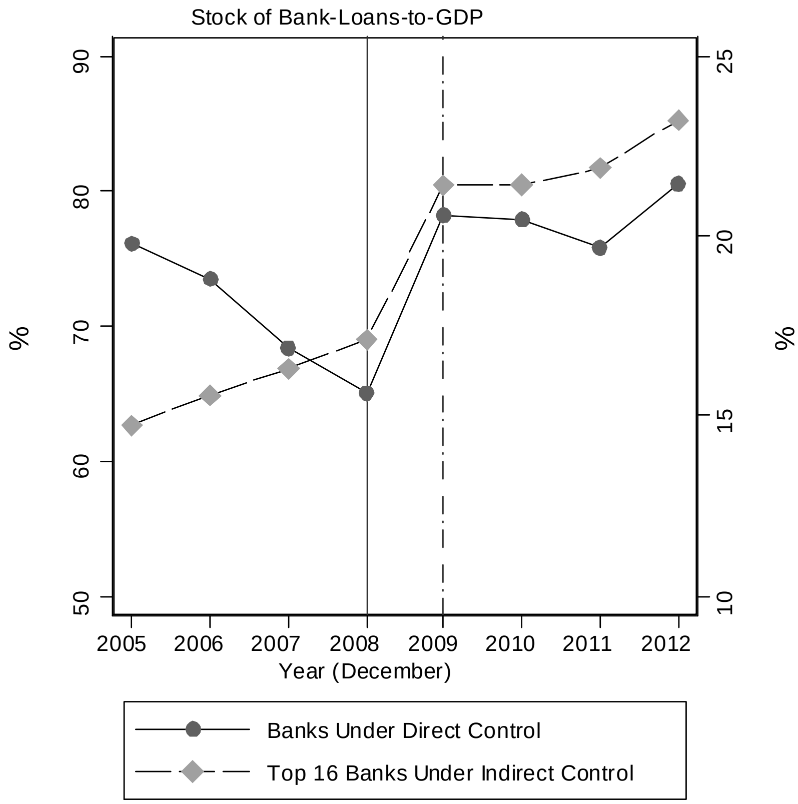


Figure 1.2. Bank-loans-to-GDP ratio in China for different types of banks. The vertical line is end of 2008, which is when the credit stimulus was announced by the Chinese government. The vertical dashed-line is end of 2009, one year after the credit push. 2008-09 is the sample we study in the empirical work. Banks under direct control of the government are: Industrial and Commercial Bank of China, Agricultural Bank of China, Bank of China, China Construction Bank, Bank of Communications, China Postal Savings Bank, Agricultural Development Bank of China, China Development Bank, and the Export-Import Bank of China. Banks under indirect control are the top 16 large commercial banks indirectly controlled by the government.

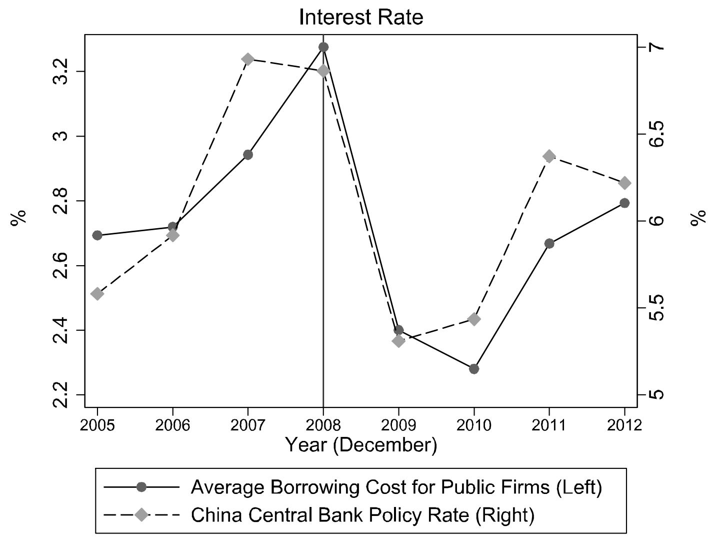


Figure 1.3. Cost of borrowing in China. This figure plots the policy rate of China's Central Bank (dashed line) and the average cost of debt for the Chinese public firms (solid line). The vertical line is end of 2008, which is when the credit stimulus was announced by the Chinese government.

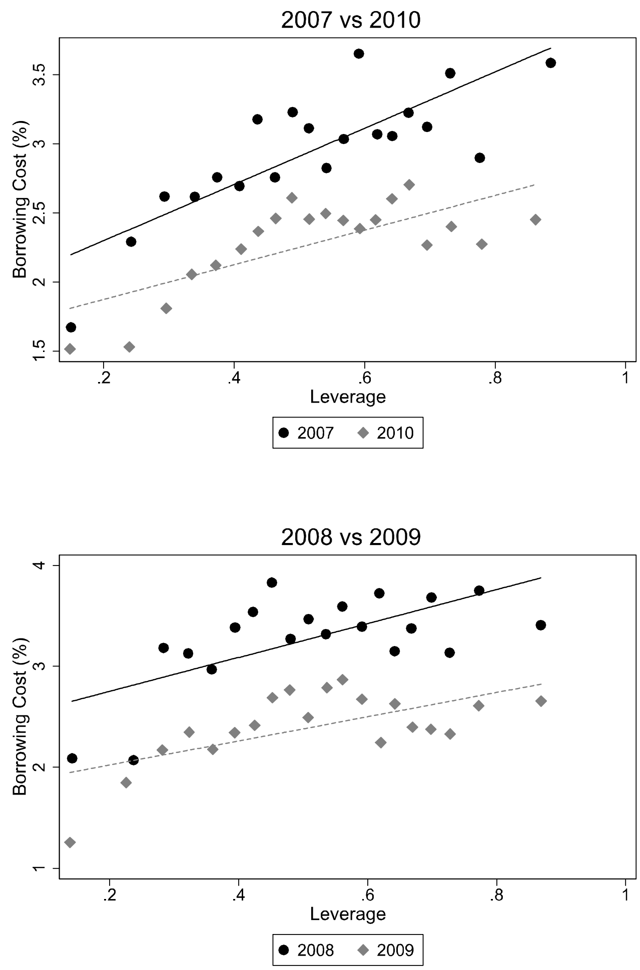


Figure 1.4. Borrowing cost versus leverage for public non-financial firms in China before and after the 2008 credit push. The figure in the upper panel compares 2007 vs. 2010. The figure in the bottom panel compares 2008 vs. 2009. For ease of appearance, the points are grouped into 20 bins of around 70 observations each. The lines are the fitted regressions for each year.

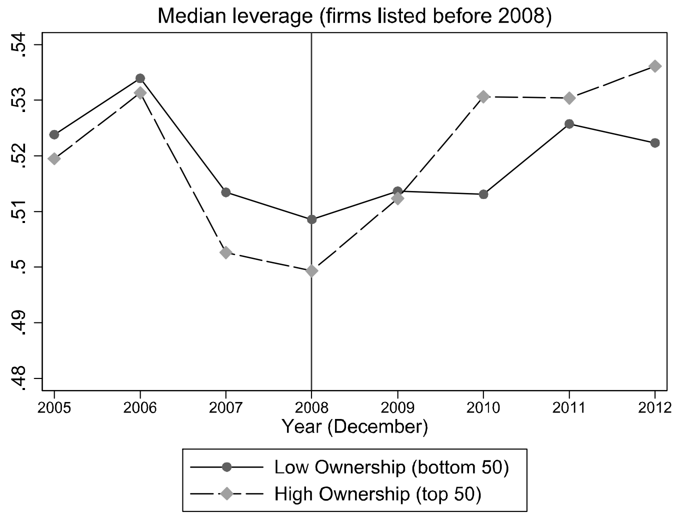


Figure 1.5. The median book leverage ratio for the non-financial public firms. The vertical line is end of 2008, which is when the credit stimulus was announced by the Chinese government. The solid line is the median leverage for the group of firms with top 50 percentile executive ownership in 2008, the dashed line is the median leverage for the group of firms with bottom 50 percentile executive ownership in 2008.

NOT FOR PUBLICATION
ONLINE APPENDIX

A. In-depth sample description

For our focal sample period of 2007-2010, we have 5,898 firm-year observations, of which, 2,914 observations are related to 769 firms with zero executive ownership and 2,984 observations are related to 778 firms with non-zero executive ownership.[18]

First, we provide sector wise descriptions of the firms given in Table 1.A1.

Insert Table 1.A1 about here

Next, we compare zero executive ownership firms with non-zero executive ownership firms across sixteen firm-characteristics including profitability, size, and market to book ratio. The results given in Table 1.A2 show that these two groups of firms differ significantly on a number of these firm characteristics. For example, the non-zero executive ownership firms are significantly larger and more profitable. We include all the variables from Panel B of Table 1.1 for this comparison purpose.

In addition, we focus on the subset of firms that report non-zero executive ownership and conduct a similar comparison between the top quartile executive ownership firms and all other firms within this subset. We have 2,984 non-zero executive ownership firm-year observations, of which, 764 are by top-quartile executive ownership firms and the 2,220 observations are by non top quartile (but positive) executive ownership firms (Table 1.A3). Again, we find that, on average, top quartile firms differ significantly compared to the non top quartile firms across multiple firm characteristics. For example, high executive ownership firms are more profitable (both higher ROA as well as fraction of firms that report a positive net income) and have a higher market to book ratio.

Insert Table 1.A2 and Table 1.A3 about here

B. Comparison of loan characteristics across firms with different levels of executive ownership

To explore if there are meaningful differences in types of loans taken by low and high executive ownership firms, we focus on four loan characteristics that are reported for all loans in the CSMAR-BLCLC dataset: the frequency of borrowing, size of the loan, collateral status, and the lender identity. We were able to match 631 firms in our original sample to the CSMAR-BLCLC database for the 2006-2008 period. We first divide the 631 matched firms in two groups.

[18] This classification between the firms is done based on the 2008 executive ownership level.

One group consists of firms that report zero executive ownership (as of the end of 2008). The other group comprises of firms that report a positive level of executive ownership.

There are 302 firms with zero executive ownership and 329 firms that have some level of executive ownership. The non-zero executive ownership firms borrow more frequently during the pre-shock period of 2006-2008 compared to the zero executive ownership firms (3.61 versus 3.07), however this difference is statistically not significant. Similarly, the difference in the average loan size of non-zero (RMB 657 million) and zero executive ownership firm (RMB 510 million) is statistically insignificant. Almost all loans are secured by collateral and the fraction of unsecured loans is quite low for both zero-executive ownership firms (1%) and non-zero executive ownership firms (2%) and this difference is marginally significant.

Finally, we examine the identity of the lending bank. Nearly one third of loans are provided by banks that are classified as government-controlled banks.[19] The fractions of total loans issued by these central government-controlled banks to the zero (0.34) and non-zero executive ownership firms are very similar (0.36) and their difference is not statistically significant.

We repeated this analysis by comparing the firms in the top quartile executive ownership level to the remaining firms. Thus, the 631 matched firms are now assigned to two groups: 171 firms in the top-quartile executive ownership level (top-quartile) and 460 firms that belong to the other three quartiles of executive ownership level (others).

The comparison of the loan characteristics again shows that the two groups (top quartile firms and other firms) are similar in frequency of borrowing, average loan amount and fraction borrowed from banks controlled by the central government. The only characteristic on which these two groups differ significantly is the fraction of loans that are unsecured (3% for the top-quartile versus 1% for the others).

Taken together, these two analyses suggest that the bank-borrower relationships were largely similar for the high and low executive ownership firms in the period immediately before the credit stimulus.

C. Estimation of borrowing cost: Pre and post credit push

One firm characteristic that deserves a special mention is the Interest Expense Ratio, which captures the borrowing costs of a firm. We estimate this variable following Pittman and Fortin (2004) as the ratio of interest expenses to total debt:

[19] This group consists of 9 banks: 1) Bank of China; 2) Agricultural Bank of China; 3) Construction Bank; 4) Industrial and Commercial Bank of China; 5) Bank of Communications; 6) China Development Bank; 7) Export Import Bank; 8) Agricultural Development Bank, and 9) Postal Savings Bank of China.

$$\begin{aligned}BorrowingCost &= InterestExpenseRatio \\ &= \frac{InterestExpense}{ShortTermDebt + LongTermDebt}\end{aligned} \tag{1.A1}$$

While the visual evidence provided in Figure 1.4 points to a significant downward shift in borrowing costs, we test this more formally by estimating a regression model of the following form:

$$\begin{aligned}Borrowing\ Cost = &\ \beta_0 + \beta_1 LeverageRatio_{it} + \beta_2 Credit\ Push_t + \\ &+ \beta_3 LeverageRatio_{it} \times Credit\ Push_t + \\ &+ \sum_k \beta_k Controls_{itk} + \alpha_{jt} + u_{it}.\end{aligned} \tag{1.A2}$$

where the Borrowing Cost is the interest expense ratio as defined in (1.A1), $Book\ Leverage_{it}$ is as defined in Equation 1.1 in the paper, $CreditPush_t$ is a dummy variable that equals one for post-stimulus period and zero for pre-stimulus period, and α_j is the industry fixed effect. The controls $\sum_k \beta_k Controls_{itk}$ are return to assets, size of the firm, market-to-book ratio and bank holding.

We report the results in Table 1.A4. The key coefficients of interest are $CreditPush_t$ and its interaction with $BookLeverage_{it}$. In column 1 of Panel A we present the results where we control for the firm characteristics and include any fixed effects. We obtain a coefficient of -0.35 for $CreditPush_t$. The coefficient for $BookLeverage_{it} \times Credit\ Push_t$ is -0.75, and it is significant at one percent level. Thus, while the credit push lowers the cost of borrowing across all firms, it is especially powerful in reducing the borrowing costs for firms that choose high leverage.

In other columns from 2 through 4, we re-estimate our benchmark regression specification by introducing industry fixed effects and using the market leverage as alternative specifications. Our results hold for these alternative specifications as well.

Insert Table 1.A4 about here

We also re-estimate Equation 1.A2 for the shorter sample period of 2008-2009. Our findings, reported in Table 1.A5, show identical results.

Insert Table 1.A5 about here

D. Bank firm relationship: Pre and post credit shock

We have been able to match 631 firms with 2116 loans related to these firms from our original sample to the CSMAR-BLCLC database over the 2006-2008 period. We classify all firms into two groups based on their executive ownership levels as of 2008. We rank the firms based on this variable. The first group consists of firms that are in the top quartile and the second group consists of the remaining firms. As before, we focus on the four loan characteristics that are reported for all loans and compare these for pre and post credit push periods. For the top quartile firms, the average loan size goes up from RMB 454 million to RMB 458 million.

Although this suggests that the average size of loans taken by the top quartile firms increases by almost RMB 4 million on average, this difference is not statistically significant. In contrast, the average loan size for other firms (not top-quartile) decreases from RMB 645 million to RMB 642 million. This drop is also statistically not significant.

The changes in other bank-loan characteristics such as frequency, collateral status and the lender identity for both top-quartile firms and other firms were found to be insignificant. This suggests that over time, bank-firm relationships remained stable and any observable increase in the leverages is caused by the credit shock.

E. Description of propensity score matching procedure

We start the matching process by creating the treatment group based on executive ownership at the end of 2008. All firms with ownership levels in the top quartile in 2008 are assigned to the high ownership (treated) group. Specifically, we create a dummy variable $TopQuartile$ which equals one if the firm ranks in the top 25% firms based on the executive ownership in 2008 and zero otherwise.

In the second step, we estimate a probit regression model using the $TopQuartile$ as the dependent variable and a large set of observable firm characteristics which include all firm-level control variables from the benchmark regression model (Equation 1.3) and additional controls: CEO turnover, whether the CEO and the chairman of the board is the same person, whether the firm has a compensation committee, the size of the board and the proportion of independent directors in the board. The choice of these additional control variables for the executive ownership is motivated by their use in prior studies of the determinant of incentive pay for the managers (Bettis et al. 2010; Dittmann et al. 2010; Kato et al. 2005; and Bertrand and Mullainathan, 2001).

The probit model is estimated over the entire cross-section of firms in our sample. This estimation allows us to calculate the predicted probability of being a top quartile executive ownership firm in 2008. We hope to find a matching firm for each top quartile executive ownership firm based on predicted probability (propensity score). This matched firm will be statistically indistinguishable from the treatment firm based on observable characteristics but will not have a high executive ownership. We employ a one-to-one matching process as outlined by D'Acunto and Rossi (2017).

The validity of the matching process is illustrated in Table 1.A11 of the Online Appendix. The first three columns under the heading "Pre-Matching" report the sample average of various firm characteristics of top-quartile executive ownership firms, of all the remaining firms (before we created matched pairs) and the t-statistics of the differences between the treatment (i.e. top-quartile firms) and the control (i.e. remaining firms) groups.

The last three columns reported under the heading "Post-Matching" repeat the same analysis but compare the top-quartile executive ownership firms to the propensity score matched firms (we were able to find matches for 303 out of 375 top quartile firms). The t-test for difference in observable firm characteristics is insignificant for all sixteen attributes.

These results provide strong evidence that our matching process yields firm pairs that are statistically indistinguishable based on observable firm characteristics.

F. Using equity-to-salary ratio

Our primary measure of managerial incentives in this paper is the fraction of firm's equity owned by its executives. This measure captures the accumulated stock holding of a firm's managers. An alternative approach to measure the executive pay-performance sensitivity is to use the ratio of the value of the stock ownership to the annual fixed cash compensation. We re-estimate our baseline specification using this alternative pay-performance sensitivity measure, denoted as equity-to-salary-ratio. We denote this new measure as $Equity\,to\,Salary_{i,2008}$. This ratio is defined as:

$$Equity\,to\,Salary_{i,2008} = \frac{Market\,Value\,of\,the\,Equity_{i,2008} \times Executive\,Ownership_{i,2008}}{Cash\,Salary\,of\,the\,Executives_{i,2008}} \tag{1.A3}$$

Where $Market\,Value\,of\,the\,Equity_{i,2008}$ is the market value of the firm at the end of 2008 and $Executive\,Ownership_{i,2008}$ is the executive ownership level of the firm at the end of 2008. The $Cash\,Salary\,of\,the\,Executives_{i,2008}$ is the average cash salary of the top three executives of the firms at the end of 2008.[20] We modify the baseline specification of Equation 1.3 above by replacing $Executive\,Ownership_{it}$ by $Equity\,to\,Salary_{i,2008}$. The new model specification is given by:

[20] Due to data limitations, the $CashSalaryoftheExecutives_{i,2008}$ variable only includes the cash salaries of the top three executives from each firm. In addition, the Equity to Salary ratio changes over the 4 years of our research period due to the change in stock price. So, we fix this ratio at year 2008.

$$
\begin{aligned}
Leverage\,Ratio_{it} = {} & \beta_0 + \beta_1 EquitytoSalary_{i,2008} + \beta_2 Credit\,Push_t + \\
& + \beta_3 EquitytoSalary_{\,i,2008} \times Credit\,Push_t + \\
& + \sum_k \beta_k Controls_{itk} + \alpha_{jt} + u_{it}.
\end{aligned} \tag{1.A4}
$$

The results of this alternative measure of executive pay-performance sensitivity for book leverage are reported in Table 1.A26 and for market leverage are reported in Table 1.A27. Again the results are consistent with our original findings.

Thus, our core findings are robust to this alternative definition of pay for performance sensitivity of executives both in the immediate aftermath of the credit shock and over a longer, four year period. However, for the longer sample period, the effect of the credit shock becomes weaker for book leverage. This diminishing impact of the credit shock on book leverage in the longer sample period is caused by other factors that existed in the market at that time.

NOT FOR PUBLICATION
ONLINE APPENDIX TABLES

Table 1.A1. Decomposition Per Sector

			Mean			
Industry	# Obs	% Obs	Int. Cost	Book Lev.	Market Lev.	Ex. Own.
Agriculture	97	1.64	3.12	0.42	0.17	2.14
Mining	222	3.76	2.45	0.45	0.18	0.14
Manufacturing	3393	57.53	2.83	0.48	0.24	2.43
Energy	310	5.26	3.81	0.59	0.38	0.02
Building	154	2.61	1.79	0.67	0.43	1.80
Wholesale & Retail	484	8.21	2.37	0.56	0.29	0.10
Transportation	247	4.19	2.72	0.45	0.28	0.01
Hotel and Catering	36	0.61	2.64	0.34	0.13	0.15
Information	162	2.75	2.01	0.38	0.16	5.87
Real Estate	493	8.36	1.97	0.57	0.33	0.42
Leasing & Business	63	1.07	2.33	0.47	0.25	3.72
Science & Technology	16	0.27	0.82	0.53	0.17	0.19
Environment	58	0.98	3.11	0.48	0.21	0.03
Education	4	0.07	4.09	0.55	0.29	0.04
Health & Social Welfare	8	0.14	0.91	0.17	0.05	0.00
Culture $ Sports	60	1.02	2.25	0.46	0.18	0.28
Comprehensive	91	1.54	2.83	0.52	0.29	0.01
Total	5898	100	2.70	0.50	0.26	1.73

Note: This table reports sector specific sample statistics of firms present in the database and contains the interest cost, book leverage, market leverage and executive ownership in percentage levels for comparison purposes. The variables are defined in the Appendix. The sample covers 2007-2010 and uses 2008 executive ownership level for classification purposes. Source: CSMAR.

Table 1.A2. Comparison Between Zero and Non-Zero Executive Ownership Firms

Variable	# Obs.		Non-Zero	Zero		
	Non-zero	Zero	Mean	Mean	t-stat	p-values
ROA (net)	2984	2914	0.07	0.06	-5.64	0.00
Firm Size	2984	2914	21.22	20.96	-6.52	0.00
Market Book	2984	2914	2.24	2.24	0.07	0.95
Stock Holding Concentration	2984	2914	0.15	0.20	15.78	0.00
Institution Ownership	2984	2914	0.07	0.06	-3.53	0.00
SOE	2984	2914	0.49	0.55	4.70	0.00
Positive Net Profit	2984	2914	0.92	0.89	-4.20	0.00
Foreign Holding	2984	2914	0.05	0.07	4.34	0.00
Dividend	2984	2914	0.59	0.47	-9.16	0.00
Bank Holding	2984	2914	0.03	0.03	-0.53	0.60
Asset Tangibility	2984	2914	0.27	0.28	2.36	0.02
CEO Turnover	2984	2914	0.17	0.22	5.28	0.00
CEO Chairman	2886	2830	0.82	0.88	5.95	0.00
Compensation Committee	2984	2914	0.83	0.83	0.24	0.80
Board Size	2938	2865	9.26	9.19	-1.42	0.16
Board Independence	2938	2865	0.36	0.36	2.46	0.01

Note: This table compares between the zero and non-zero executive ownership firms across the sixteen firm characteristic variables for the sample period 2007-2010 and uses 2008 executive ownership level for classification purposes. The variables are defined in the Appendix.

Table 1.A3. Comparison Between Top Quartile Executive Ownership Firms and Other Firms

Variable	# Obs.		Top Quartile	Others		
	Top Quartile	Others	Mean	Mean	t-stat	p-values
ROA (net)	764	2220	0.08	0.06	-8.68	0.00
Firm Size	764	2220	20.66	21.41	13.60	0.00
Market Book	764	2220	3.15	1.93	-16.42	0.00
Stock Holding Concentration	764	2220	0.15	0.15	-0.08	0.93
Institution Ownership	764	2220	0.06	0.08	4.61	0.00
SOE	764	2220	0.13	0.61	24.92	0.00
Positive Net Profit	764	2220	0.95	0.91	-4.25	0.00
Foreign Shareholding	764	2220	0.06	0.04	-1.42	0.16
Dividend	764	2220	0.67	0.57	-4.98	0.00
Bank Holding	764	2220	0.01	0.04	4.52	0.00
Asset Tangibility	764	2220	0.23	0.28	6.99	0.00
CEO Turnover	764	2220	0.14	0.18	2.66	0.01
CEO Chairman	740	2146	0.67	0.87	12.53	0.00
Compensation Committee	764	2220	0.75	0.85	6.68	0.00
Board Size	753	2138	8.85	9.40	7.00	0.00
Board Independence	753	2185	0.36	0.36	-2.01	0.04

Note: This table compares between the top quartile executive ownership firms and other firms (only based on non-zero ownership firms) across the sixteen firm characteristics variables based on the 2008 executive ownership level. The variables are defined in the Appendix.

Table 1.A4. Cost of Leverage Before and After the Credit Push, 2007-2010

	Interest Expense			
	(1)	(2)	(3)	(4)
Book Leverage$_{it}$ × Credit Push$_t$	-0.750***	-0.714***		
	(0.003)	(0.004)		
Book Leverage$_{it}$	1.813***	2.184***		
	(0.000)	(0.000)		
Market Leverage$_{it}$ × Credit Push$_t$			-0.699***	-0.418*
			(0.002)	(0.063)
Book Leverage$_{it}$			1.849***	2.149***
			(0.000)	(0.000)
CreditPush$_t$	-0.345**	-0.349**	-0.492***	-0.539***
	(0.013)	(0.011)	(0.000)	(0.000)
Firm's Controls	Yes	Yes	Yes	Yes
Industry FE	No	Yes	No	Yes
Observations	4283	4283	4283	4283
R^2	0.123	0.205	0.117	0.194

Note: The sample covers 2007-2010. The controls are return to assets, size of the firm, market-to-book ratio, bank holding. p-values are in parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% level. Standard errors are clustered at the firm level.

Table 1.A5. Cost of Leverage Before and After the Credit Push, 2008-2009

	Interest Expense			
	(1)	(2)	(3)	(4)
Book Leverage$_{it}$ × Credit Push$_t$	-0.845***	-0.903***		
	(0.009)	(0.004)		
Book Leverage$_{it}$	1.732***	2.201***		
	(0.000)	(0.000)		
Market Leverage$_{it}$ × Credit Push$_t$			-0.861**	-0.744**
			(0.021)	(0.039)
Book Leverage$_{it}$			2.025***	2.382***
			(0.000)	(0.000)
CreditPush$_t$	-0.301	-0.256	-0.318**	-0.292**
	(0.125)	(0.184)	(0.032)	(0.044)
Firm's Controls	Yes	Yes	Yes	Yes
Industry FE	No	Yes	No	Yes
Observations	1956	1956	1956	1956
R^2	0.117	0.205	0.118	0.203

Note: The sample covers 2008-2009. The controls are return to assets, size of the firm, market-to-book ratio, bank holding. p-values are in parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% level. Standard errors are clustered at the firm level.

Table 1.A6. Executive Ownership and Market Leverage

Panel A: 2007-2010

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.134***	0.125***	0.137***
	(0.000)	(0.001)	(0.001)
Executive Ownership$_{it}$	-0.115***	-0.090**	-0.116***
	(0.006)	(0.022)	(0.003)
Credit Push$_t$	-0.022***	-0.024***	-0.054*
	(0.000)	(0.000)	(0.091)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	5898	5898	5898
R^2	0.584	0.613	0.642

Panel B: 2008-2009

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.361***	0.343***	0.327***
	(0.000)	(0.001)	(0.001)
Executive Ownership$_{it}$	-0.255***	-0.229**	-0.220***
	(0.000)	(0.00)	(0.000)
Credit Push$_t$	-0.051***	-0.058***	-0.038*
	(0.000)	(0.000)	(0.094)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	3007	3007	3007
R^2	0.604	0.636	0.640

Note: The sample covers both the 2007-2010 (in Panel A) and 2008-2009 (in Panel B) periods and estimates Equation 1.3 with Market Leverage as the dependent variable. Executive Ownership$_{it}$ is the number of shares owned by the executives divided by shares outstanding. Credit Push$_t$ denotes whether t $\geq$ 2009. Controls are: ROA, firm size, market-to-book ratio, assets tangibility, dividend, positive net profit, SOE, ownership concentration, institutional ownership, bank holding and foreign holding. We include industry and industry-year FE. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A7. Top Quartile Executive Ownership and Market Leverage

Panel A: 2007-2010

	(1)	(2)	(3)
$TopQuartile_{2008} \times Credit\ Push_t$	0.027***	0.023**	0.027***
	(0.000)	(0.000)	(0.000)
$TopQuartile_{2008}$	-0.028***	-0.023***	-0.021***
	(0.000)	(0.000)	(0.000)
$Credit\ Push_t$	-0.024***	-0.025***	0.050
	(0.000)	(0.000)	(0.115)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	5898	5898	5898
R^2	0.584	0.613	0.642

Panel B: 2008-2009

	(1)	(2)	(3)
$TopQuartile_{2008} \times Credit\ Push_t$	0.075***	0.070***	0.068***
	(0.000)	(0.000)	(0.000)
$TopQuartile_{2008}$	-0.062***	-0.058***	-0.056***
	(0.000)	(0.000)	(0.000)
$Credit\ Push_t$	0.057***	0.063***	0.037
	(0.000)	(0.000)	(0.107)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	3007	3007	3007
R^2	0.606	0.638	0.641

Note: The sample covers both the 2007-2010 (in Panel A) and 2008-2009 (in Panel B) periods and estimates Equation 1.4 with Market Leverage as the dependent variable. Credit $Push_t$ denotes whether $t \geq 2009$. $TopQuartile_{2008}$ represents a dummy for the firms belonging to the top quartile of the executive ownership level in 2008. The controls are same as in Table 1.A6. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A8. Executive Ownership Quartiles and Market Leverage

Panel A: 2007-2010

	(1)	(2)	(3)
$ExQuartile3_{2008} \times$ Credit $Push_t$	-0.023**	-0.024**	-0.026**
	(0.038)	(0.025)	(0.011)
$ExQuartile2_{2008} \times$ Credit $Push_t$	-0.022**	-0.021**	-0.027***
	(0.030)	(0.037)	(0.006)
$ExQuartile1_{2008} \times$ Credit $Push_t$	-0.035***	-0.032***	-0.037***
	(0.001)	(0.002)	(0.000)
Credit $Push_t$	0.004	0.000	0.084
	(0.675)	(0.982)	(0.163)
Firm's Controls	Yes	Yes	Yes
Ownership Quartile Control	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	2933	2933	2933
R^2	0.595	0.637	0.674

Panel B: 2008-2009

	(1)	(2)	(3)
$ExQuartile3_{2008} \times$ Credit $Push_t$	-0.060***	-0.060***	-0.054***
	(0.000)	(0.000)	(0.000)
$ExQuartile2_{2008} \times$ Credit $Push_t$	-0.096***	-0.092***	-0.083***
	(0.000)	(0.000)	(0.000)
$ExQuartile1_{2008} \times$ Credit $Push_t$	-0.112***	-0.108***	-0.102***
	(0.000)	(0.000)	(0.000)
Credit $Push_t$	0.035**	0.022	0.135***
	(0.013)	(0.100)	(0.000)
Firm's Controls	Yes	Yes	Yes
Ownership Quartile Control	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	1501	1501	1501
R^2	0.631	0.676	0.679

Note: This table estimates Equation 1.5 with Market Leverage as the dependent variable. The sample covers only non-zero executive ownership firms for the sample periods 2007-2010 in Panel A and 2008-2009 in Panel B. Credit $Push_t$ denotes whether t $\geq$ 2009. ExQuartile variables are dummies representing the non-zero executive ownership firms belonging to the four quartiles of executive ownership levels in 2008. ExQuartile4 is used as the reference category. The controls are same as in Table 1.A6. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A9. Executive Ownership and Market Leverage, 2006-2012.

	(1)	(2)	(3)
Executive Ownership$_{i,2006}$ × Year$_{2006}$	-0.022	-0.005	-0.047
	(0.739)	(0.929)	(0.454)
Executive Ownership$_{i,2007}$ × Year$_{2007}$	0.429***	0.408***	0.378***
	(0.000)	(0.000)	(0.000)
Executive Ownership$_{i,2009}$ × Year$_{2009}$	0.340***	0.322***	0.306***
	(0.000)	(0.000)	(0.000)
Executive Ownership$_{i,2010}$ × Year$_{2010}$	0.320***	0.294***	0.289***
	(0.000)	(0.000)	(0.000)
Executive Ownership$_{i,2011}$ × Year$_{2011}$	0.062	0.043	0.069
	(0.261)	(0.418)	(0.161)
Executive Ownership$_{i,2012}$ × Year$_{2012}$	0.058	0.047	0.079*
	(0.236)	(0.295)	(0.089)
Executive Ownership$_{it}$	-0.266***	-0.224***	-0.222***
	(0.000)	(0.000)	(0.000)
Firm's Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	10221	10221	10221
R^2	0.597	0.631	0.644

Note: This table estimates Equation 1.6. The sample covers 2006-2012 with Market Leverage as the dependent variable. Executive Ownership$_{it}$ is the number of shares owned by the executives divided by shares outstanding. Year$_t$ variable represents dummies for the years 2006, 2007, 2009, 2010, 2011 and 2012, with 2008 taken as the base year. The remaining controls are same as in Table 1.A6. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A10. Executive Ownership and Market Leverage: Controlling Bank-Firm Relations.

Panel A: 2007-2010

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.053	0.059	0.074
	(0.304)	(0.251)	(0.130)
Executive Ownership$_{it}$	-0.073	-0.055	-0.083*
	(0.152)	(0.277)	(0.083)
Credit Push$_t$	-0.025***	-0.026***	0.020
	(0.000)	(0.000)	(0.587)
Prior Bank-Borrower Relationship	Yes	Yes	Yes
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	2473	2473	2473
R^2	0.633	0.657	0.691

Panel B: 2008-2009

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.322***	0.315***	0.301***
	(0.000)	(0.001)	(0.000)
Executive Ownership$_{it}$	-0.246***	-0.227***	-0.218***
	(0.000)	(0.000)	(0.000)
Credit Push$_t$	-0.058***	-0.065***	-0.019
	(0.000)	(0.000)	(0.534)
Prior Bank-Borrower Relationship	Yes	Yes	Yes
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	1256	1256	1256
R^2	0.656	0.682	0.684

Note: This table estimates Equation 1.7 with Market Leverage as the dependent variable and reports the estimation of the benchmark model controlling for the prior bank-borrower relationship for both the 2007-2010 (in Panel A) and 2008-2009 (in Panel B) periods. Executive Ownership$_{it}$ is the number of shares owned by the executives divided by shares outstanding. Credit Push$_t$ denotes whether t $\geq$ 2009. The prior-bank-borrower relationship is an indicator variable that equals to one if firm i has borrowed from bank b at least once during the 2006-2008 period (i.e. pre-credit push period). We create this variable for the top 20 commercial banks, the 3 policy banks and a single "Other" category for all the remaining banks using the CSMAR-Bank Loans of Chinese Listed Companies (CSMAR-BLCLC) dataset. The controls are same as in Table 1.A6. p-values are in parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% level. Standard errors are clustered at the firm level.

Table 1.A11. Comparison of Top Quartile Firms and Matched Sample

	Pre Matching			Post Matching		
Variable	Treated	Control	t-stat	Treated	Control	t-stat
ROA (net)	0.04	0.07	-6.42***	0.07	0.07	0.10
Firm Size	21.06	20.88	2.03***	20.89	20.93	-0.42
Market Book	1.12	1.42	-5.05***	1.33	1.25	0.89
Stock Holding Concentration	0.19	0.14	6.50***	0.14	0.14	-0.25
Institution Ownership	0.07	0.07	-0.35	0.06	0.06	0.02
SOE	0.63	0.33	10.33***	0.41	0.37	0.92
Positive Net Profit	0.83	0.91	-3.74***	0.89	0.89	-0.26
Foreign Shareholding	0.07	0.07	0.30	0.08	0.07	0.63
Dividend	0.49	0.64	-5.33***	0.59	0.60	-0.33
Bank Holding	0.04	0.01	2.53***	0.02	0.02	0.00
Asset Tangibility	0.29	0.25	3.88***	0.25	0.25	-0.46
CEO Turnover	0.21	0.14	2.97***	0.13	0.15	-0.82
CEO Chairman	0.89	0.74	7.14***	0.77	0.80	-0.89
Compensation Committee	0.83	0.74	3.69***	0.80	0.79	0.40
Board Size	9.31	8.99	2.84***	8.86	9.02	-1.08
Board Independence	0.36	0.36	0.49	0.36	0.36	-0.34
Observations	375	1135		303	303	

Note: "Treated" represents Top Quartile firms (i.e. firms in the fourth quartile) while "Control" represents: a) remaining firms in the "Pre Credit Shock" scenario and b) the matched sample in the "Post Credit Shock" scenario. *, ** and *** indicate significance at the 10%, 5% and 1% level. The variables are defined in the Appendix.

Table 1.A12. Executive Ownership and Market Leverage: Propensity Score Matching

Panel A: 2007-2010

	(1)	(2)	(3)
$TopQuartile_{2008} \times Credit\ Push_t$	0.017***	0.015***	0.015***
	(0.004)	(0.008)	(0.008)
$TopQuartile_{2008}$	-0.017**	-0.020***	-0.020***
	(0.019)	(0.005)	(0.004)
$Credit\ Push_t$	-0.033***	-0.034***	-0.059***
	(0.000)	(0.000)	(0.000)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	2407	2407	2407
R^2	0.614	0.642	0.675

Panel B: 2008-2009

	(1)	(2)	(3)
$TopQuartile_{2008} \times Credit\ Push_t$	0.019**	0.018**	0.019**
	(0.031)	(0.035)	(0.023)
$TopQuartile_{2008}$	-0.020*	-0.020**	-0.020**
	(0.055)	(0.046)	(0.040)
$Credit\ Push_t$	-0.058***	-0.066***	-0.021
	(0.000)	(0.000)	(0.329)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	1204	1204	1204
R^2	0.627	0.658	0.665

Note: This table estimates Equation 1.8 with Market Leverage as the dependent variable for both the 2007-2010 (in Panel A) and 2008-2009 (in Panel B) periods using the 303 firm pairs created on the basis of propensity scores on the 2008 values of the control variables using the nearest neighbor approach. Variables are defined in the Appendix. All 16 firm characteristic variables in Table 1.A11 have been used as controls to calculate the propensity scores. p-values are in parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% level. Standard errors are clustered at the firm level.

Table 1.A13. Executive Ownership and Book Leverage with Year FE, 2007-2010

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.152***	0.139***	0.139***
	(0.000)	(0.001)	(0.001)
Executive Ownership$_{it}$	-0.224***	-0.184***	-0.183***
	(0.000)	(0.000)	(0.000)
Firm's Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	5898	5898	5898
R^2	0.327	0.361	0.364

Note: This table estimates the benchmark equation with year fixed effects as given in Equation 1.9. The sample covers the 2007-2010 period with Book Leverage as the dependent variable. Executive Ownership$_{it}$ is the number of shares owned by the executives divided by shares outstanding. CreditPush$_t$ is a dummy that takes the value of 1 if year $\geq$ 2009 and zero otherwise. Controls are: ROA, firm size, market-to-book ratio, assets tangibility, dividend, positive net profit, SOE, ownership concentration, institutional ownership, bank holding and foreign holding. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A14. Executive Ownership and Market Leverage with Year FE, 2007-2010

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.141***	0.131***	0.137***
	(0.000)	(0.000)	(0.000)
Executive Ownership$_{it}$	-0.141***	-0.115***	-0.116***
	(0.001)	(0.003)	(0.003)
Firm's Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	5898	5898	5898
R^2	0.601	0.633	0.642

Note: This table estimates the benchmark equation with year fixed effects as given in Equation 1.9. The sample covers the 2007-2010 period with Market Leverage as the dependent variable. Executive Ownership$_{it}$ is the number of shares owned by the executives divided by shares outstanding. CreditPush$_t$ is a dummy that takes the value of 1 if year $\geq$ 2009 and zero otherwise. Controls are: ROA, firm size, market-to-book ratio, assets tangibility, dividend, positive net profit, SOE, ownership concentration, institutional ownership, bank holding and foreign holding. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A15. Executive Ownership and Book Leverage: Placebo Test

Panel A: 2011-2014

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Post2012	0.058	0.061	0.060
	(0.290)	(0.243)	(0.263)
Executive Ownership$_{it}$	-0.168**	-0.125**	-0.124*
	(0.013)	(0.047)	(0.052)
Post2012	-0.006*	-0.007**	0.117**
	(0.086)	(0.027)	(0.014)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	5994	5994	5994
R^2	0.311	0.368	0.369

Panel B: 2011-2012

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Post2012	0.015	0.025	0.031
	(0.766)	(0.602)	(0.527)
Executive Ownership$_{it}$	-0.156**	-0.119**	-0.122*
	(0.022)	(0.063)	(0.057)
Post2012	0.007**	0.007**	0.078
	(0.015)	(0.021)	(0.106)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	3001	3001	3001
R^2	0.322	0.377	0.377

Note: The sample covers 2011-2014 in Panel A and 2011-2012 in Panel B to estimate Equation 1.3 with Book Leverage as the dependent variable. The sample uses only the publicly listed firms that are non directly controlled by the Chinese government. Executive Ownership$_{it}$ is the number of shares owned by the executives divided by shares outstanding. Credit Push$_t$ denotes whether t $\geq$ 2009. The controls are same as in Table 1.A6. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A16. Executive Ownership and Market Leverage: Placebo Test

Panel A: 2011-2014

	(1)	(2)	(3)
Executive Ownership_{it} × Post2012	0.047	0.049	0.046
	(0.299)	(0.244)	(0.284)
Executive Ownership_{it}	-0.145**	-0.090*	-0.090*
	(0.011)	(0.076)	(0.073)
Post2012	-0.008***	-0.010***	-0.112***
	(0.001)	(0.000)	(0.005)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	5994	5994	5994
R^2	0.575	0.643	0.650

Panel B: 2011-2012

	(1)	(2)	(3)
Executive Ownership_{it} × Post2012	0.005	0.021	0.019
	(0.913)	(0.622)	(0.659)
Executive Ownership_{it}	-0.132**	-0.091*	-0.090*
	(0.028)	(0.087)	(0.084)
Post2012	0.000	0.000	-0.121***
	(0.804)	(0.950)	(0.000)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	3001	3001	3001
R^2	0.590	0.657	0.657

Note: The sample covers 2011-2014 in Panel A and 2011-2012 in Panel B to estimate Equation 1.3 with Market Leverage as the dependent variable. The sample uses only the publicly listed firms that are non directly controlled by the Chinese government. Executive Ownership_{it} is the number of shares owned by the executives divided by shares outstanding. Credit Push_t denotes whether t $\geq$ 2009. The controls are same as in Table 1.A6. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A17. Executive Ownership and Book Leverage: Firm Fixed Effects

Panel A: 2007-2010

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.049	0.043	0.045
	(0.140)	(0.170)	(0.151)
Executive Ownership$_{it}$	0.022	0.042	0.033
	(0.623)	(0.353)	(0.470)
Credit Push$_t$	0.016**	0.009***	0.005
	(0.000)	(0.002)	(0.852)
Firm's Controls	No	Yes	Yes
Firm FE	Yes	Yes	Yes
Industry × Year FE	No	No	Yes
Observations	5898	5898	5898
R^2	0.018	0.123	0.146

Panel B: 2008-2009

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.063**	0.062**	0.065**
	(0.039)	(0.042)	(0.035)
Executive Ownership$_{it}$	0.026	0.052	0.052
	(0.751)	(0.476)	(0.477)
Credit Push$_t$	0.010***	0.016***	0.020
	(0.000)	(0.000)	(0.237)
Firm's Controls	No	Yes	Yes
Firm FE	Yes	Yes	Yes
Industry × Year FE	No	No	Yes
Observations	3007	3007	3007
R^2	0.021	0.149	0.156

Note: This equation estimates Equation 1.3 with Firm Fixed Effects and Book Leverage as the dependent variable. The sample covers 2007-2010 in Panel A and 2008-2009 in Panel B. Executive Ownership$_{it}$ is the number of shares owned by the executives divided by shares outstanding. CreditPush$_t$ is a dummy that takes the value of 1 if year $\geq$ 2009 and zero otherwise. The remaining controls are same as in Table 1.A6. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A18. Executive Ownership and Market Leverage: Firm Fixed Effects

Panel A: 2007-2010

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.019	0.094***	0.108***
	(0.371)	(0.001)	(0.000)
Executive Ownership$_{it}$	0.007	-0.003	0.005
	(0.822)	(0.945)	(0.870)
Credit Push$_t$	-0.030***	-0.027***	-0.017
	(0.000)	(0.000)	(0.101)
Firm's Controls	No	Yes	Yes
Firm FE	Yes	Yes	Yes
Industry × Year FE	No	No	Yes
Observations	5898	5898	5898
R^2	0.026	0.425	0.628

Panel B: 2008-2009

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.220***	0.210***	0.209***
	(0.000)	(0.000)	(0.000)
Executive Ownership$_{it}$	-0.130**	-0.104**	-0.096**
	(0.011)	(0.025)	(0.046)
Credit Push$_t$	-0.128***	-0.124***	-0.074***
	(0.000)	(0.000)	(0.000)
Firm's Controls	No	Yes	Yes
Firm FE	Yes	Yes	Yes
Industry × Year FE	No	No	Yes
Observations	3007	3007	3007
R^2	0.664	0.696	0.703

Note: This equation estimates Equation 1.3 with Firm Fixed Effects and Market Leverage as the dependent variable. The sample covers 2007-2010 in Panel A and 2008-2009 in Panel B. Executive Ownership$_{it}$ is the number of shares owned by the executives divided by shares outstanding. CreditPush$_t$ is a dummy that takes the value of 1 if year $\geq$ 2009 and zero otherwise. The remaining controls are same as in Table 1.A6. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A19. Executive Ownership and Book Leverage: Non-SOE Sample

Panel A: 2007-2010

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.176***	0.165***	0.154***
	(0.000)	(0.000)	(0.001)
Executive Ownership$_{it}$	-0.286***	-0.240***	-0.214***
	(0.000)	(0.000)	(0.000)
Credit Push$_t$	0.002	0.000	0.007
	(0.697)	(0.940)	(0.911)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	2846	2846	2846
R^2	0.312	0.348	0.371

Panel B: 2008-2009

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.167***	0.158***	0.157***
	(0.000)	(0.001)	(0.002)
Executive Ownership$_{it}$	-0.224***	-0.183***	-0.182***
	(0.000)	(0.002)	(0.003)
Credit Push$_t$	0.057***	0.051***	0.095**
	(0.000)	(0.000)	(0.040)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	1469	1469	1469
R^2	0.372	0.405	0.406

Note: The sample covers 2007-2010 in Panel A and 2008-2009 in Panel B to estimate Equation 1.3 with Book Leverage as the dependent variable. This table provides results for the estimation of Equation 1.3 and uses only the publicly listed firms that are non directly controlled by the Chinese government. Executive Ownership$_{it}$ is the number of shares owned by the executives divided by shares outstanding. Credit Push$_t$ denotes whether t $\geq$ 2009. The controls are same as in Table 1.A6. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A20. Executive Ownership and Market Leverage: Non-SOE Sample

Panel A: 2007-2010

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.124***	0.114***	0.127***
	(0.000)	(0.000)	(0.000)
Executive Ownership$_{it}$	-0.161***	-0.122**	-0.140***
	(0.000)	(0.000)	(0.000)
Credit Push$_t$	-0.025***	-0.027***	-0.031
	(0.000)	(0.000)	(0.391)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	2846	2846	2846
R^2	0.579	0.609	0.638

Panel B: 2008-2009

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.283***	0.267***	0.240***
	(0.000)	(0.000)	(0.000)
Executive Ownership$_{it}$	-0.266***	-0.225***	-0.209***
	(0.000)	(0.000)	(0.000)
Credit Push$_t$	-0.049***	-0.057***	-0.036
	(0.000)	(0.000)	(0.168)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	1469	1469	1469
R^2	0.597	0.629	0.634

Note: The sample covers both the 2007-2010 (in Panel A) and 2008-2009 (in Panel B) periods to estimate Equation 1.3 with Market Leverage as the dependent variable. This table provides results for the estimation of Equation 1.3 and uses only the publicly listed firms that are non directly controlled by the Chinese government. Executive Ownership$_{it}$ is the number of shares owned by the executives divided by shares outstanding. Credit Push$_t$ denotes whether t $\geq$ 2009. The controls are same as in Table 1.A6. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A21. Executive Ownership and Book Leverage Without Infrastructure Firms

Panel A: 2007-2010

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.172***	0.157***	0.150***
	(0.000)	(0.001)	(0.001)
Executive Ownership$_{it}$	-0.257***	-0.212***	-0.189***
	(0.000)	(0.000)	(0.000)
Credit Push$_t$	0.009**	0.008**	0.050
	(0.011)	(0.016)	(0.282)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	5025	5025	5025
R^2	0.291	0.312	0.330

Panel B: 2008-2009

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.206***	0.188***	0.199***
	(0.000)	(0.000)	(0.000)
Executive Ownership$_{it}$	-0.219***	-0.177***	-0.182***
	(0.000)	(0.004)	(0.003)
Credit Push$_t$	0.063***	0.058***	0.120***
	(0.000)	(0.000)	(0.003)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	2563	2563	2563
R^2	0.339	0.357	0.358

Note: This table estimates Equation 1.3 with Book Leverage as the dependent variable but without the infrastructure firms. The sample covers both the 2007-2010 (in Panel A) and 2008-2009 (in Panel B) periods. Executive Ownership$_{it}$ is the number of shares owned by the executives divided by shares outstanding. CreditPush$_t$ is a dummy that takes the value of 1 if year $\geq$ 2009 and zero otherwise. The remaining controls are same as in Table 1.A6. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A22. Executive Ownership and Market Leverage Without Infrastructure Firms

Panel A: 2007-2010

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.137***	0.125***	0.141***
	(0.000)	(0.001)	(0.000)
Executive Ownership$_{it}$	-0.156***	-0.127***	-0.153***
	(0.000)	(0.000)	(0.000)
Credit Push$_t$	-0.025***	-0.026***	-0.055*
	(0.000)	(0.000)	(0.085)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	5025	5025	5025
R^2	0.588	0.602	0.628

Panel B: 2008-2009

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.350***	0.333***	0.337***
	(0.000)	(0.000)	(0.000)
Executive Ownership$_{it}$	-0.290***	-0.264***	-0.264***
	(0.000)	(0.000)	(0.000)
Credit Push$_t$	-0.053***	-0.058***	0.037
	(0.000)	(0.000)	(0.110)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	2563	2563	2563
R^2	0.602	0.618	0.620

Note: This table estimates Equation 1.3 with Market Leverage as the dependent variable but without the infrastructure firms. The sample covers both the 2007-2010 (in Panel A) and 2008-2009 (in Panel B) periods. Executive Ownership$_{it}$ is the number of shares owned by the executives divided by shares outstanding. CreditPush$_t$ is a dummy that takes the value of 1 if year $\geq$ 2009 and zero otherwise. The remaining controls are same as in Table 1.A6. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A23. Executive Ownership and Log of Debt After the Credit Push

Panel A: 2007-2010

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	0.703***	0.593***	0.570***
	(0.000)	(0.001)	(0.002)
Executive Ownership$_{it}$	-1.882***	-1.429***	-1.317***
	(0.000)	(0.000)	(0.000)
Credit Push$_t$	0.184***	0.155***	0.386**
	(0.000)	(0.000)	(0.046)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	5898	5898	5898
R^2	0.752	0.802	0.808

Panel B: 2008-2009

	(1)	(2)	(3)
Executive Ownership$_{it}$ × Credit Push$_t$	1.017***	0.876***	0.866***
	(0.000)	(0.000)	(0.000)
Executive Ownership$_{it}$	-1.864***	-1.433***	-1.426***
	(0.000)	(0.000)	(0.000)
Credit Push$_t$	0.455***	0.372***	0.663***
	(0.000)	(0.000)	(0.000)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	3007	3007	3007
R^2	0.758	0.808	0.809

Note: This table estimates Equation 1.10 for the periods 2007-2010 (in Panel A) and 2008-2009 (in Panel B). ExecutiveOwnership$_{it}$ is the number of shares owned by the executives divided by shares outstanding. CreditPush$_t$ is a dummy that takes the value of 1 if year $\geq$ 2009 and zero otherwise. The remaining controls are same as in Table 1.A6. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A24. Executive Ownership and Book Leverage: Ownership at 2008 level

Panel A: 2007-2010

	(1)	(2)	(3)
Executive Ownership$_{i,2008}$ × Credit Push$_t$	0.139***	0.124***	0.110***
	(0.000)	(0.001)	(0.002)
Executive Ownership$_{i,2008}$	-0.285***	-0.237***	-0.206***
	(0.000)	(0.001)	(0.000)
Credit Push$_t$	0.011***	0.010***	0.050
	(0.001)	(0.002)	(0.293)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	5897	5897	5897
R^2	0.311	0.349	0.365

Panel B: 2008-2009

	(1)	(2)	(3)
Executive Ownership$_{i,2008}$ × Credit Push$_t$	0.159***	0.142***	0.143***
	(0.000)	(0.000)	(0.000)
Executive Ownership$_{i,2008}$	-0.233***	-0.189***	-0.189***
	(0.000)	(0.001)	(0.001)
Credit Push$_t$	0.062***	0.055***	0.120***
	(0.002)	(0.003)	(0.003)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	3007	3007	3007
R^2	0.355	0.392	0.393

Note: The table estimates Equation 1.3 with ownership structure fixed at 2008 level with Book Leverage as the dependent variable. The sample covers 2007-2010 in Panel A and 2008-2009 in Panel B. Executive Ownership$_{i,2008}$ is the number of shares owned by the executives divided by shares outstanding in 2008. Credit Push$_t$ denotes whether t $\geq$ 2009. The controls are same as in Table 1.A6. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A25. Executive Ownership and Market Leverage: Ownership at 2008 level

Panel A: 2007-2010

	(1)	(2)	(3)
Executive $\text{Ownership}_{i,2008}$ × Credit Push_t	0.135***	0.127***	0.143***
	(0.000)	(0.000)	(0.000)
Executive $\text{Ownership}_{i,2008}$	-0.146***	-0.119**	-0.149***
	(0.000)	(0.002)	(0.000)
Credit Push_t	-0.022***	-0.024***	-0.052
	(0.000)	(0.000)	(0.105)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	5897	5897	5897
R^2	0.585	0.613	0.642

Panel B: 2008-2009

	(1)	(2)	(3)
Executive $\text{Ownership}_{i,2008}$ × Credit Push_t	0.341***	0.326***	0.310***
	(0.000)	(0.000)	(0.000)
Executive $\text{Ownership}_{i,2008}$	-0.267***	-0.240**	-0.231***
	(0.000)	(0.000)	(0.000)
Credit Push_t	-0.051***	-0.058***	-0.038*
	(0.000)	(0.000)	(0.099)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	3007	3007	3007
R^2	0.604	0.636	0.639

Note: The table estimates Equation 1.3 with ownership structure fixed at 2008 level with Market Leverage as the dependent variable. The sample covers 2007-2010 in Panel A and 2008-2009 in Panel B. Executive $\text{Ownership}_{i,2008}$ is the number of shares owned by the executives divided by shares outstanding in 2008. Credit Push_t denotes whether $t \geq 2009$. The controls are same as in Table 1.A6. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

Table 1.A26. Executive Ownership and Book Leverage: Equity-to-Salary Ratio in 2008

Panel A: 2007-2010

	(1)	(2)	(3)
Equity-to-Salary$_{i,2008}$ × Credit Push$_t$	0.0000489**	0.0000428**	0.0000332*
	(0.012)	(0.023)	(0.078)
Equity-to-Salary$_{i,2008}$	-0.000094***	-0.0000734***	-0.000055**
	(0.000)	(0.001)	(0.011)
Credit Push$_t$	0.0104***	0.00966***	0.0513
	(0.001)	(0.002)	(0.278)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry x Year FE	No	No	Yes
Observations	5833	5833	5833
R2	0.313	0.352	0.369

Panel B: 2008-2009

	(1)	(2)	(3)
Equity-to-Salary$_{i,2008}$ × Credit Push$_t$	0.0000568***	0.0000501***	0.0000489**
	(0.004)	(0.008)	(0.011)
Equity-to-Salary$_{i,2008}$	-0.0000633***	-0.0000451**	-0.0000440*
	(0.007)	(0.048)	(0.055)
Credit Push$_t$	0.0628***	0.0564***	0.0124***
	(0.000)	(0.000)	(0.002)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry x Year FE	No	No	Yes
Observations	2980	2980	2980
R2	0.355	0.393	0.394

Note: This table reports the estimation of Equation 1.A4. This model specification uses Book Leverage as the dependent variable for the 2007-2010 sample period (Panel A) and for the 2008-2009 sample period (Panel B). The variables are defined in the Appendix. The controls and significance levels are same as in Table 1.A6. p-values are in parentheses. Standard errors are clustered at the firm level.

Table 1.A27. Executive Ownership and Market Leverage: Equity-to-Salary Ratio in 2008

Panel A: 2007-2010

	(1)	(2)	(3)
Equity-to-Salary$_{i,2008}\times$ Credit Push$_t$	0.0000447***	0.0000412***	0.0000501***
	(0.003)	(0.004)	(0.000)
Equity-to-Salary$_{i,2008}$	-0.0000475**	-0.0000345*	-0.0000513***
	(0.021)	(0.075)	(0.007)
Credit Push$_t$	-0.0216***	-0.0229***	0.0520
	(0.000)	(0.000)	(0.106)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry x Year FE	No	No	Yes
Observations	5833	5833	5833
R2	0.586	0.615	0.644

Panel B: 2008-2009

	(1)	(2)	(3)
Equity-to-Salary$_{i,2008}\times$ Credit Push$_t$	0.000135***	0.000130***	0.000122***
	(0.000)	(0.000)	(0.000)
Equity-to-Salary$_{i,2008}$	-0.0000992***	-0.0000879***	-0.0000834***
	(0.000)	(0.000)	(0.000)
Credit Push$_t$	-0.0489***	-0.0561***	-0.0395*
	(0.000)	(0.000)	(0.082)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry x Year FE	No	No	Yes
Observations	2980	2980	2980
R2	0.604	0.637	0.640

Note: This table reports the estimation of Equation 1.A4. This model specification uses Market Leverage as the dependent variable for the 2007-2010 sample period (Panel A) and for the 2008-2009 sample period (Panel B). The variables are defined in the Appendix. The controls and significance levels are same as in Table 1.A6. p-values are in parentheses. Standard errors are clustered at the firm level.

Table 1.A28. Executive Ownership and Firm Leverage, 2006-2012

Panel A: Book Leverage

	(1)	(2)	(3)
Executive Ownership$_{i,t}$ × Credit Push$_t$	0.108**	0.089**	0.089**
	(0.018)	(0.043)	(0.043)
Executive Ownership$_{i,t}$	-0.235***	-0.184***	-0.168***
	(0.000)	(0.000)	(0.001)
Credit Push$_t$	-0.005	-0.004	-0.091*
	(0.156)	(0.259)	(0.065)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	10221	10221	10221
R^2	0.303	0.344	0.361

Panel B: Market Leverage

	(1)	(2)	(3)
Executive Ownership$_{i,t}$ × Credit Push$_t$	0.052	0.039	0.058*
	(0.161)	(0.264)	(0.091)
Executive Ownership$_{i,t}$	-0.097**	-0.062	-0.083**
	(0.031)	(0.147)	(0.042)
Credit Push$_t$	-0.012***	-0.012***	-0.055
	(0.000)	(0.000)	(0.144)
Firm's Controls	Yes	Yes	Yes
Industry FE	No	Yes	No
Industry × Year FE	No	No	Yes
Observations	10221	10221	10221
R^2	0.583	0.615	0.641

Note: The sample covers 2006-2012 and estimates Equation 1.1. Executive Ownership$_{it}$ is the number of shares owned by the executives divided by shares outstanding. Credit Push$_t$ denotes whether t $\geq$ 2009. The controls are same as in Table 1.A6. p-values are in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% levels. Standard errors are clustered at the firm level.

NOT FOR PUBLICATION
ONLINE APPENDIX FIGURES

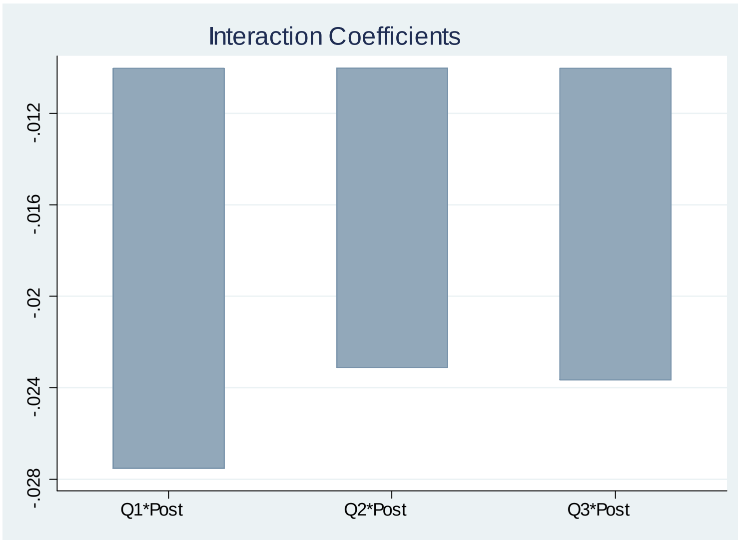


Figure 1.A1. Interaction Between Executive Ownership Quartiles and Credit Shock with Book Leverage, 2007-2010. This figure illustrates the almost monotonous increase in the impact of the interaction term between different quartiles of executive ownership and credit shock on Book Leverage for the period 2007-2010.

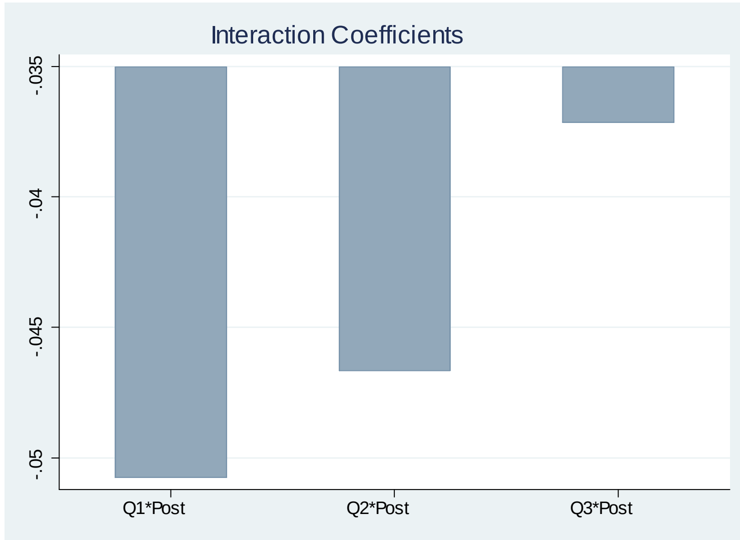


Figure 1.A2. Interaction Between Executive Ownership Quartiles and Credit Shock with Book Leverage, 2008-2009. This figure illustrates the monotonous increase in the impact of the interaction term between different quartiles of executive ownership and credit shock on Book Leverage for the period 2008-2009.

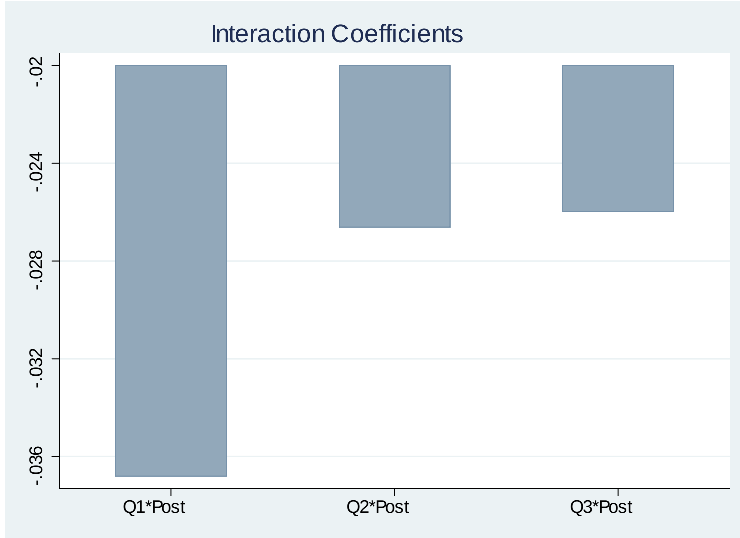


Figure 1.A3. Interaction Between Executive Ownership Quartiles and Credit Shock with Market Leverage, 2007-2010. This figure illustrates the monotonous increase in the impact of the interaction term between different quartiles of executive ownership and credit shock on Market Leverage for the period 2007-2010.

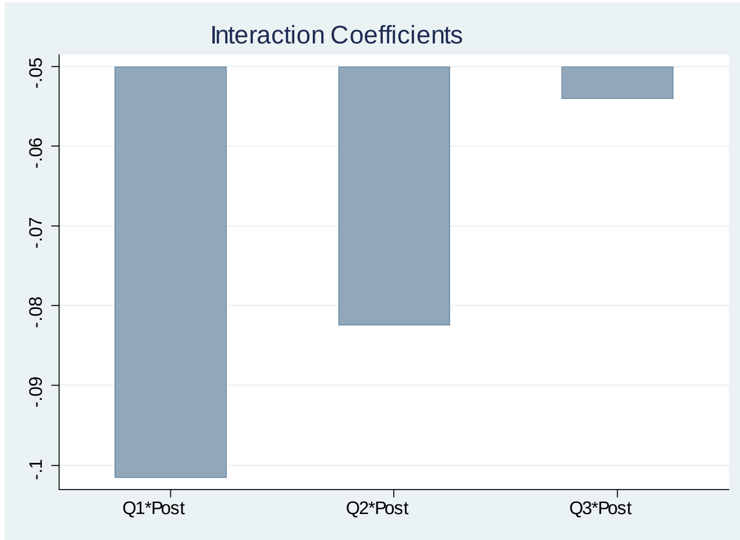


Figure 1.A4. Interaction Between Executive Ownership Quartiles and Credit Shock with Market Leverage, 2008-2009. This figure illustrates the monotonous increase in the impact of the interaction term between different quartiles of executive ownership and credit shock on Market Leverage for the period 2008-2009.

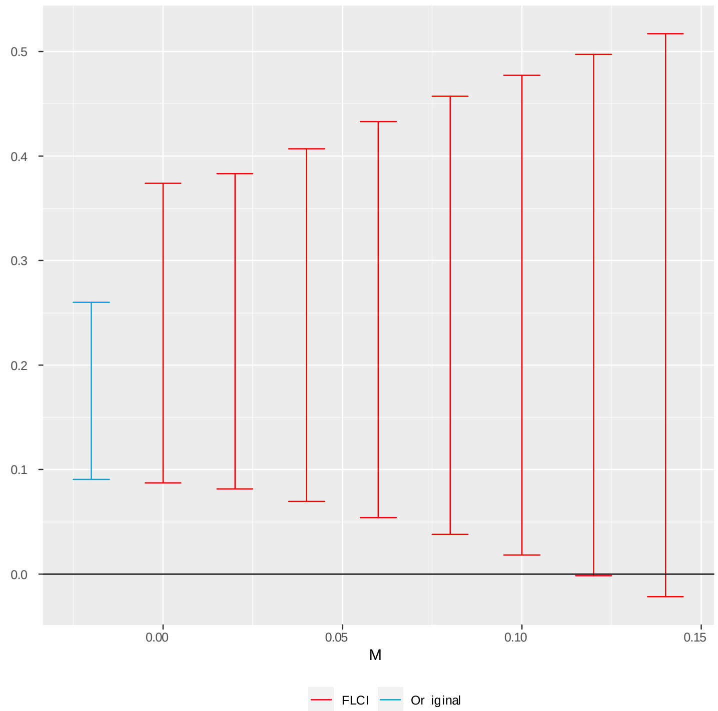


Figure 1.A5: Sensitivity Analysis for Dynamic Regression with Book Leverage: This figure reports the sensitivity analysis to failures of the parallel lines assumption following Rambachan and Roth (2019). We check the coefficient of the interaction term between executive ownership and the 2009 year dummy with Book Leverage as the dependent variable. The sample period is 2006-2012. The x-axis is the values of the nonlinearity parameter (M) that captures the amount of deviation from parallel trends. The y-axis is the range of estimated coefficient values for the interaction coefficient. "FLCI" refers to the optimal fixed length confidence intervals for the interaction coefficient assuming $M > 0$. "Original" is the confidence interval for the interaction coefficient when $M = 0$ (i.e. the parallel trend assumption perfectly holds). Both FLCI and CI are using 95% confidence level.

Chapter 2

A MODEL OF MANAGERIAL COMPENSATION, FIRM LEVERAGE AND CREDIT STIMULUS[21]

2.1 Introduction

How much and in what form should a firm's owners pay a manager hired to run a firm? How will the compensation structure affect the manager's risk-taking through incurring debt to expand a firm's size? How will the CEO compensation structure affect a firm's sensitivity to government stimulus policies? These questions are central in corporate finance research. The literature so far has focused on models where at least one of the previous three elements is exogenous. This paper analyzes them in a model which is novel because CEO's compensation, firm's leverage and borrowing spreads are all endogenous. In this regard our paper expands the work of Jaggia and Thakor (1994) who discussed the relation between CEO's actions, capital structure and firm's compensation design.

The model considers that a firm operates a project that generates risky cash flows. The risky cash flow is captured by incorporating a stochastic shock to the firm's productivity. The firm invests at the beginning of the period and the returns are realized only at the end of the period. The firm's cash flows are stochastic and increasing in the amount invested. Apart from the realized cash flow, the firm has no other assets. Thus, the final value of the firm equals the total cash flow generated by the project. This value is both observable and verifiable at the end of the period.

There are three agents of interest in this model: a shareholder, a CEO and a lender. The CEO is risk averse while the shareholder and the lender are risk neutral. The firm's cash flows are stochastic and increasing in the amount invested. The expected cash flow is also increasing in CEO's effort. The CEO is averse to effort as it is costly.

[21]The materials in this chapter are based on joint research work with Sandeep Dahiya, Lei Ge and Pedro Gete.

Following John and John (1993) and Carlson and Lazrak (2010), we assume that the shareholder is risk neutral and has an investment opportunity. However, she lacks the managerial talent to exploit this opportunity. Thus, the shareholder hires an external CEO and provides the necessary capital to the CEO for exploiting this investment opportunity. CEO effort is unobservable by the shareholder. This makes it impossible for the shareholder to write a compensation contract based on the CEO effort level. To motivate the CEO, the shareholder offers her a compensation contract featuring both fixed and variable components. The CEO receives the fixed component regardless of the final cash flow realized by the firm. Thus, the fixed component protects the financial interest of the CEO. The variable component is a fraction of the final cash flow realized by the firm. This component motivates the CEO to expand the scope of the firm's operations by borrowing more. A larger debt expands the scope of the firm and can potentially lead to a larger cash flow. However, the shareholder realizes that the CEO may increase the leverage to an undesirable level thus enhancing the default probability significantly. Thus, the shareholder needs to set the variable compensation at an optimal level. Our model endogenizes this variable compensation choice.

We follow Bernanke et al. (1999) to model the debt contract. The risk neutral lender prepares the debt contract and prices this debt by charging a spread over its own cost of funds. The cost of fund for the lender increases with the lending amount. The default risk is increasing in the lending amount, especially in high risk situations. To counter this default risk, the lending rates are increasing in risk levels for the same borrowing amount. Furthermore, when faced with a positive credit stimulus (e.g., a government subsidy), lender's cost of fund decreases. This allows an increase in credit supply to the market and the CEO finds it easier to borrow.

The CEO is assumed to be risk averse. The expected cash flow is increasing in CEO's effort. However, the effort is costly for the CEO. A larger variable component implies that the CEO compensation has a higher pay for performance sensitivity. The CEO receives an offer from the shareholders. After accepting the contract, the CEO chooses her effort level as well as the debt amount. The CEO will put in effort only when she has a higher variable pay and/or has a lower cost of effort for a given level of variable compensation.

We obtain two sets of results. The first set relates to the relationship between executive compensation and capital structure in the cross-section of firms. John and John (1993) triggered a large literature studying the relationship between the level and structure of executive compensation and risk-taking. Benchmark models such as Carlson and Lazrak (2010) predict a negative correlation that is driven by CEO's risk aversion. However, empirical studies have reported conflicting results. For example, Bryan et al. (2000), Lewellen (2006) and Coles et al. (2006) document a positive relationship between risk taking proxied by firm leverage and pay for performance sensitivity. In contrast, Berger et al. (1997) and Mehran (1992) report that higher pay for performance sensitivity is associated with lower firm leverage. To solve this puzzle, we add the shareholder's optimal compensation decision to our model. Our model provides a possible explanation for the existing conflict in empirical studies that investigate the relationship between executive compensation structure and firm leverage. The key is that we uncover a new channel of complementarity between CEO effort and firm leverage that works in opposite direction to CEO's risk aversion.[22] Chakraborti et al. (2021) study the 2008 Chinese credit stimulus and confirm our predictions.

The second set of results shows maximizing the impact of credit policies requires combining such policies with policies that encourage firms to borrow more. For example, tax incentives that encourage higher executive ownership are likely to cause the corporations to react more to credit expansion policies if such tax incentives increase executive ownership.[23] This result complements papers such as Bebchuk and Goldstein (2011), who study economic policies in which banks hold back from lending to firms with financially viable projects.

Most of the literature examining the impact of credit expansions has focused on how such policies influence banks' lending decisions, i.e., the "supply channel" of credit (Gambacorta and Shin, 2016). To the best of our knowledge, we are the first to show that the structure of

[22] To keep our model tractable, we do not consider stock options which may create different incentives and can potentially lead to other insights.

[23] Gorry et al. (2017) show that the structure of CEO compensation is sensitive to tax incentives.

executive compensation can also affect the "demand" for borrowing. When the compensation structure makes a risk-averse CEO more exposed to her firm's risk then the CEO reduces firm leverage to lower her earnings risk. However, once we allow shareholders to optimally choose the CEO's compensation, there is a novel mechanism in the opposite direction that can explain the conflicting findings found in empirical literature.

The new mechanism requires that firm's leverage and CEO's effort are complementary to the shareholder. Greater CEO effort makes higher future cash flow more likely, and this allows the firm to sustain a higher level of leverage. This implies that shareholders desiring a higher debt level will include a larger variable component in the CEO compensation contract to encourage the CEO to exert more effort. Thus, the optimal action of shareholders can generate a positive cross-sectional relationship between the level of leverage and the degree of pay for performance sensitivity (i.e., the variable CEO compensation).

Hence, this paper shows that the relation between leverage and variable compensation can be either positive or negative, depending on the channel that dominates. This is exactly what the empirical literature has found. We also make two novel predictions. First, total compensation is increasing in leverage; and second, leverage and the ratio of variable to fixed compensation are positively correlated. That is, the optimal compensation contract requires increase in both fixed as well as variable compensation components if the shareholder wants the CEO to increase effort and leverage at the same time (for example, to profit from better investment opportunities). However, the optimal variable pay grows faster than the fixed pay.

The paper proceeds as follows. Section 2.3 connects this paper to the existing literature. Section 2.4 presents the model. Section 2.5 studies the relationship between executive compensation and capital structure in the cross-section of firms. Section 2.6 studies the reaction to a credit stimulus. Section 2.7 concludes.

2.2 Introducción

¿Cuánto y en qué forma deben pagar los propietarios de una empresa a un gerente contratado para dirigir una empresa? ¿Cómo afectará la estructura de compensación la asunción de riesgos del gerente al incurrir en deuda para expandir el tamaño de una empresa? ¿Cómo afectará la estructura de compensación del director ejecutivo la sensibilidad de una empresa a las políticas de estímulo del gobierno? Estas preguntas son centrales en la investigación de las finanzas corporativas. La literatura hasta el momento se ha centrado en modelos en los que al menos uno de los tres elementos anteriores es exógeno. Este documento los analiza en un modelo que es novedoso porque la compensación del director general, el apalancamiento de la empresa y los márgenes de endeudamiento son todos endógenos. En este sentido, nuestro artículo amplía el trabajo de Jaggia y Thakor (1994), quienes discutieron la relación entre las acciones del director ejecutivo, la estructura de capital y el diseño de compensación de la empresa.

El modelo considera que una empresa opera un proyecto que genera flujos de caja riesgosos. El flujo de efectivo riesgoso se captura incorporando un shock estocástico a la productividad de la empresa. La empresa invierte al comienzo del período y los rendimientos se obtienen solo al final del período. Los flujos de efectivo de la empresa son estocásticos y aumentan en la cantidad invertida. Aparte del flujo de efectivo realizado, la empresa no tiene otros activos. Así, el valor final de la empresa es igual al flujo de caja total generado por el proyecto. Este valor es tanto observable como verificable al final del período.

Hay tres agentes de interés en este modelo: un accionista, un director general y un prestamista. El CEO tiene aversión al riesgo, mientras que el accionista y el prestamista son neutrales al riesgo. Los flujos de efectivo de la empresa son estocásticos y aumentan en la cantidad invertida. El flujo de efectivo esperado también está aumentando en el esfuerzo del CEO. El CEO es reacio al esfuerzo, ya que es costoso.

Siguiendo a John y John (1993) y Carlson y Lazrak (2010), asumimos que el accionista es neutral al riesgo y tiene una oportunidad de inversión. Sin embargo, carece del talento gerencial para explotar esta oportunidad. Así, el accionista contrata a un director general externo y proporciona el capital necesario al director general para explotar esta oportunidad de inversión. El esfuerzo del CEO no es observable por el accionista. Esto hace que sea imposible para el accionista escribir un contrato de compensación basado en el nivel de esfuerzo del CEO. Para motivar a la directora general, el accionista le ofrece un contrato de remuneración con componentes tanto fijos como variables. El director general recibe el componente fijo independientemente del flujo de caja final obtenido por la empresa. Así, el componente fijo protege el interés financiero del director general. El componente variable es una fracción del flujo de efectivo final realizado por la empresa. Este componente motiva al director general a ampliar el alcance de las operaciones de la empresa pidiendo más préstamos. Una deuda más grande amplía el alcance de la empresa y puede conducir potencialmente a un mayor flujo de efectivo. Sin embargo, el accionista se da cuenta de que el CEO puede aumentar el apalancamiento a un nivel indeseable, lo que aumenta significativamente la probabilidad de incumplimiento. Por tanto, el accionista necesita fijar la retribución variable en un nivel óptimo. Nuestro modelo endogeniza esta opción de compensación variable.

Seguimos a Bernanke et al. (1999) para modelar el contrato de deuda. El prestamista neutral al riesgo prepara el contrato de deuda y valora esta deuda cobrando un diferencial sobre su propio costo de fondos. El costo del fondo para el prestamista aumenta con el monto del préstamo. El riesgo de impago es cada vez mayor en el monto del préstamo, especialmente en situaciones de alto riesgo. Para contrarrestar este riesgo de incumplimiento, las tasas de préstamo están aumentando en niveles de riesgo por el mismo monto de préstamo. Además, cuando se enfrenta a un estímulo crediticio positivo (por ejemplo, un subsidio del gobierno), el costo de financiamiento del prestamista disminuye. Esto permite un aumento en la oferta de crédito al mercado y al CEO le resulta más fácil pedir prestado.

Se supone que el CEO tiene aversión al riesgo. El flujo de efectivo esperado está aumentando en el esfuerzo del CEO. Sin embargo, el esfuerzo es costoso para el CEO. Un componente variable más grande implica que la compensación del CEO tiene una mayor sensibilidad al rendimiento. El CEO recibe una oferta de los accionistas. Después de aceptar el contrato, el CEO elige su nivel de esfuerzo y el monto de la deuda. El CEO se esforzará solo cuando tenga un salario variable más alto y/o tenga un costo de esfuerzo más bajo para un nivel dado de compensación variable.

Obtenemos dos conjuntos de resultados. El primer conjunto se relaciona con la relación entre la compensación ejecutiva y la estructura de capital en la muestra representativa de empresas. John y John (1993) generaron una gran cantidad de literatura que estudia la relación entre el nivel y la estructura de la compensación ejecutiva y la asunción de riesgos. Los modelos de referencia como Carlson y Lazrak (2010) predicen una correlación negativa impulsada por la aversión al riesgo del director general. Sin embargo, los estudios empíricos han reportado resultados contradictorios. Por ejemplo, Brian et al. (2000), Lewellen (2006) y Coles et al. (2006) documentan una relación positiva entre la asunción de riesgos representada por el apalancamiento de la empresa y la sensibilidad al pago por desempeño. Por el contrario, Berger et al. (1997) y Mehran (1992) informan que una paga más alta por sensibilidad al desempeño está asociada con un menor apalancamiento de la empresa. Para resolver este rompecabezas, agregamos la decisión de compensación óptima del accionista a nuestro modelo. Nuestro modelo proporciona una posible explicación para el conflicto existente en los estudios empíricos que investigan la relación entre la estructura de compensación ejecutiva y el apalancamiento de la empresa. La clave es que descubrimos un nuevo canal de complementariedad entre el esfuerzo del CEO y el apalancamiento de la empresa que funciona en dirección opuesta a la aversión al riesgo del CEO.[24] Chakraborti et al. (2021) estudian el estímulo crediticio Chino de 2008 y confirman nuestras predicciones.

El segundo conjunto de resultados muestra que maximizar el impacto de las políticas crediticias requiere combinarlas con políticas que aumenten la disposición de las empresas a endeudarse. Por ejemplo, los incentivos fiscales que fomentan una mayor propiedad de acciones gerenciales pueden hacer que las corporaciones reaccionen más a las expansiones crediticias si

[24]Para mantener nuestro modelo manejable, no consideramos las opciones sobre acciones que pueden crear diferentes incentivos y potencialmente pueden conducir a otros conocimientos.

estos incentivos conducen a una mayor propiedad gerencial.[25]

Este resultado complementa trabajos como los de Bebchuk y Goldstein (2011), quienes estudian políticas económicas en las que los bancos se abstienen de prestar a empresas con buenos proyectos.

La mayor parte de la literatura que examina el impacto de las expansiones crediticias se ha centrado en cómo dichas políticas influyen en las decisiones crediticias de los bancos, es decir, el "canal de suministro" de crédito (Gambacorta y Shin, 2016). Hasta donde sabemos, somos los primeros en demostrar que la estructura de compensación ejecutiva también puede afectar la "demanda" de préstamos. Cuando la estructura de compensación hace que un director ejecutivo adverso al riesgo esté más expuesto al riesgo de su empresa, entonces el director ejecutivo reduce el apalancamiento de la empresa para reducir su riesgo de ganancias. Sin embargo, una vez que permitimos que los accionistas elijan de manera óptima la compensación del CEO, existe un mecanismo novedoso en la dirección opuesta que puede explicar los hallazgos contradictorios encontrados en la literatura empírica.

El nuevo mecanismo requiere que el apalancamiento de la empresa y el esfuerzo del CEO sean complementarios al del accionista. Un mayor esfuerzo del CEO hace más probable un mayor flujo de caja futuro, y esto permite que la empresa mantenga un mayor nivel de apalancamiento. Esto implica que los accionistas que deseen un mayor nivel de deuda incluirán un mayor componente variable en el contrato de compensación del director ejecutivo para alentar al director general a esforzarse más. Así, la acción óptima de los accionistas puede generar una relación transversal positiva entre el nivel de apalancamiento y el grado de sensibilidad del pago por desempeño (es decir, la compensación variable del CEO).

Por lo tanto, este artículo muestra que la relación entre el apalancamiento y la compensación variable puede ser positiva o negativa, dependiendo del canal que domine. Esto es exactamente lo que ha encontrado la literatura empírica. También hacemos dos predicciones novedosas. Primero, la compensación total está aumentando en apalancamiento; y segundo, el apalan-

[25] Gorry et al. (2017) proporcionan evidencia de que la estructura de compensación ejecutiva es sensible a los impuestos.

camiento y la relación de compensación variable a fija están positivamente correlacionados. Es decir, el contrato de compensación óptima requiere un aumento tanto en los componentes de compensación fijos como variables si el accionista quiere que el CEO aumente el esfuerzo y el apalancamiento al mismo tiempo (por ejemplo, para beneficiarse de mejores oportunidades de inversión). Sin embargo, el salario variable óptimo crece más rápido que el salario fijo.

El documento procede de la siguiente manera. La Sección 2.3 conecta este documento con la literatura existente. La Sección 2.4 presenta el modelo. La Sección 2.5 estudia la relación entre la remuneración de los ejecutivos y la estructura de capital en la muestra representativa de empresas. La Sección 2.6 estudia la reacción a un estímulo crediticio. La Sección 2.7 concluye.

2.3 Contribution to the literature

This paper bridges two existing streams of theoretical literature on CEO compensation and firm leverage.[26] The models in the first strand of literature study a firm's leverage preferences when the CEO compensation is exogenous. Papers falling in this first stream of literature include John and John (1993), Carlson and Lazrak (2010) or Panousi and Papanikolaou (2012). The models in the second stream of literature identify optimal compensation, under exogenous firm leverage choice without any default and endogenous credit spreads. Papers that can be classified into this stream of literature include Dittmann et al. (2010, 2017), He (2011), Bolton et al. (2015) and Gete and Gomez (2017). In this paper, we show novel insights by using CEO compensation, leverage and CEO effort all as endogenous.

Our findings are closely aligned to those of Jaggia and Thakor (1994). However, the model of Jaggia and Thakor (1994) requires the firms with high leverage to pay higher CEO compensation in order to motivate the CEO to acquire firm specific skills. Golan et al. (2015) show that CEO compensation level also depends on the existing level of market competition. As our primary focus is understanding the relationship between executive compensation and firm leverage preference, we exclude market competition from our model. Cheng et al. (2015) show that the total CEO compensation is increasing in the overall risk of the firm. However, the firm

[26] Edmans and Gabaix (2016) is a recent survey.

risk is exogenous in their model. In our model, the CEO chooses the induced risk associated with increased leverage.

Importantly, we also show that based on their CEO compensation structure, firms react differently when exposed to increased credit supply. This mechanism provides a new perspective and adds to the existing bank lending channel literature. Our findings closely follow Agarwal et al. (2018) who examine how the individual (credit card) borrowers react to the US credit expansion. They show that the volume of additional credit an individual obtains is directly influenced by her propensity to borrow (i.e., her credit demand). We complement their study by focusing on the credit demand of corporate borrowers.

2.4 Model

Our model assumes a firm operating a project that generates risky cash flows. We model the cash flow risk by incorporating a stochastic shock to the firm's productivity. At the start of the period (date 0) the firm invests and the returns are realized at the end of the period (date 1). There are three agents: a shareholder, a CEO and a lender. The shareholder lacks the ability to operate the firm and must hire an outside CEO with the required skills.

At date 0, the shareholder offers the CEO a mutually acceptable compensation contract. After accepting the offer, the CEO chooses to borrow an amount (B) and invests the newly borrowed amount in a project (the firm already has N of equity investment, made by the shareholder).[27] The lender prices this debt (B) by charging a spread over its own cost of funds. At date 1, the project generates a cash flow. Apart from the realized cash flow, the firm has no other assets. Thus, the final value of the firm (Y) equals the total cash flow generated by the project. This value is both observable and verifiable at date 1.

To operate the project, the CEO expends costly effort (p). CEO's effort increases the expected future cash flow for the firm. Following the typical setup employed in the compensation literature (e.g., Gayle et al., 2015), we assume that CEO effort is private information and the

[27] We limit the new capital only to debt. This allows us to abstract away from issues of equity dilution as well as information frictions between different equity holders.

shareholder cannot observe it directly. Thus, it is impossible for the shareholder to write a compensation contract based on CEO effort level. The compensation contract has two components: a fixed component (A) and a variable component (v) that is a fraction of the realized cash flow of the firm at date 1. Figure 2.1 recapitulates our model's timeline.

Insert Figure 2.1 about here

2.4.1 The firm

At date 0, the firm has a pre-determined level of equity (N) and the CEO can borrow (B) to expand the size of the project:

$$K = B + N. \tag{2.1}$$

Capital (K) is the total investment of the firm. Conceptually, one can think of the equity (N) either in terms of cash investment or operating assets already in place contributed by the shareholder.

The firm's cash flow (Y) at date 1 is stochastic and depends both on the capital employed (K) and on the productivity shock (ω):

$$Y(\omega, K) = \omega R_k K,$$

where R_k is a constant (parameter return of capital) and ω is the productivity shock. The productivity shock (ω) follows a lognormal cumulative density function.[28] This setup mirrors the specification in Bernanke et al. (1999) where ω represents the idiosyncratic risk of a specific firm while R_k is the aggregate return to capital.

In our model, the CEO's effort (p) has an impact on the final realized value via the productivity shock (ω). We model the expected mean of the associated lognormal distribution of productivity shock (ω) as a function of CEO's effort:

$$\omega \sim \ln \mathcal{N}(\omega; \mu(p), \sigma), \tag{2.2}$$

[28] We provide a more detailed justification behind choosing log-normal distribution in the Online Appendix.

$$\mu(p) = \psi p^{\varepsilon} - \frac{\sigma^2}{2}, \tag{2.3}$$

where σ is the idiosyncratic uncertainty of the productivity shock, $\psi > 0$ and $\varepsilon < 1$ are respectively the level and the shape parameters for the effect of CEO's effort on productivity shock (ω). We call σ as the productivity variance parameter.

From (2.2) and (2.3) it follows that the firm's expected productivity is increasing and concave in effort. That is,

$$\mathbb{E}\left[\omega\right] = e^{\mu(p)+\frac{\sigma^2}{2}} = e^{\psi p^{\varepsilon}}. \tag{2.4}$$

We denote the cumulative density function of ω by $F(\omega; p)$ to stress that the expected value of the productivity shock (ω) is a function of CEO's effort (p).

2.4.2 The lender

The lender faces a cost of funds $R_B(1-\tau)$. The parameter $\tau \geq 0$ is a government credit subsidy that shifts credit supply. There are several ways to interpret this parameter. For example, Jeske et al. (2013) refer to it as a loan guarantee. It is also interpreted as a monetary policy or government subsidy that lowers lender's cost of funds.

Following Bernanke et al. (1999), we model the financial contract as a default threshold ($\hat{\omega}$) and a loan size (B) such that when the firm receives a shock ω above the threshold $\hat{\omega}$ then it pays $\hat{\omega} R_k K$ to the lender. When the shock ω is below the threshold $\hat{\omega}$ then the firm defaults and the lender seizes the firm's assets after paying a proportional foreclosure cost, $\gamma > 0$. The endogenous lending rate R_L is implicitly defined as:

$$R_L B = \hat{\omega} R_k K. \tag{2.5}$$

The lender's participation constraint requires that the lender must break even:

$$\int_0^{\hat{\omega}} (1-\gamma)\, \omega R_k K \, dF(\omega; p) + \int_{\hat{\omega}}^{\infty} R_L B \, dF(\omega; p) = R_B(1-\tau)B. \tag{2.6}$$

The first integral is the lender's expected revenue in the default scenario. That is, the value of the firm's assets net of foreclosure costs. The second integral in the left hand side of Equation (2.6) is the expected revenue for the lender when the firm repays (i.e., when ω is above the threshold $\hat{\omega}$). The right hand side of Equation (2.6) is the cost of funds for the lender.

Equation (2.6) determines the endogenous lending spreads. Since the firm's productivity shock (and the resulting cash flows) are not known ex-ante (at date 0), the lender needs to set the lending rate higher than her cost of funds to compensate for the default probability and for foreclosure costs. Using Equations (2.1), (2.5) and (2.6) we get:

$$\int_0^{\hat{\omega}} (1-\gamma)\,\omega R_k(B+N)\,dF(\omega;p) + \int_{\hat{\omega}}^{\infty} \hat{\omega} R_k(B+N)\,dF(\omega;p) = R_B(1-\tau)B. \qquad 2.7$$

Equation (2.7) describes the lender's participation constraint when it is binding.

The difference in lending rates across different uncertainty levels is higher at higher leverage levels (see Figure 2.2).

Insert Figure 2.2 about here

Furthermore, the lender faces a cost of fund, $R_B(1-\tau)$, where τ ($\tau \geq 0$) represents the government credit stimulus that increases credit supply. Therefore, with increasing value of τ, lender's cost of fund decreases, and the CEO finds it easier to borrow. However, a risk averse CEO will be skeptical to borrow more as it increases her own financial risk. As a consequence, shareholders must offer the CEO a higher fixed compensation to offset her personal financial risk and to borrow. Thus, we expect the variable to fixed CEO compensation ratio to decrease in credit subsidy (τ). This is exactly what we find in Figure 2.3.

Insert Figure 2.3 about here

2.4.3 The compensation contract

Similar to the approach of John and John (1993) and, Carlson and Lazrak (2010), we study compensation contracts with both a fixed component ($0 \leqslant A$) and a variable component denoted as a share, $(v;\, 0 \leqslant v \leqslant 1)$, of the firm's value at date 1. The total payoff for the CEO is $s(\omega)$,

$$s(\omega) = \begin{cases} A + v\left[Y\left(\omega, K\right) - R_L B\right] & \text{if} \quad \omega \geq \hat{\omega}, \\ A & \text{if} \quad \omega < \hat{\omega}. \end{cases} \tag{2.8}$$

That is, when the firm defaults (i.e., when $\omega < \hat{\omega}$) , the CEO only receives the fixed compensation (A). When the firm repays (i.e., when $\omega \geq \hat{\omega}$) , the CEO gets the fixed salary (A) and a share (v) of the firm's final cash flow net of payments to the lender.

In a default/foreclosure scenario, the CEO must receive the fixed component (A) of her salary. Thus, the lender includes the CEO fixed compensation (A) while calculating the foreclosure cost. Hence, the fixed CEO compensation (A) is captured through the foreclosure cost parameter (γ).

2.4.4 The CEO

The CEO bears the cost of effort denoted by $c(p)$,

$$c(p) = \phi p^{\rho}, \tag{2.9}$$

which we assume is increasing and convex. That is, $\phi > 0$ and $\rho > 1$.

Given the compensation contract, the CEO decides her effort (p) and the firms' borrowing contract $(B,\ \hat{\omega})$ to maximize her expected utility subject to the lender's participation constraint. That is, the CEO solves:

$$\max_{\{\hat{\omega}, p, B\}} \int_{\hat{\omega}}^{\infty} u\left(A + v\left(Y\left(\omega, K\right) - R_L B\right) - c(p)\right)\, dF(\omega; p) + \int_{0}^{\hat{\omega}} u\left(A - c(p)\right)\, dF(\omega; p) \tag{2.10}$$

$$\text{subject to } \ (2.7)\,.$$

The CEO will put in effort only when she has a higher variable pay (see Figure 2.4) and/or has a lower cost of effort for a given level of variable to total compensation ratio (see Figure

2.5).

Insert Figures 2.4 and 2.5 about here

We assume CEO effort (p) as a resource that is under the CEO's control. CEO effort and the firm's borrowing contract ($B, \hat{\omega}$) depend on the pre-determined compensation package that the CEO receives. Since, effort is a resource available to the CEO and she decides whether and what level of effort she will exert, we define CEO's cost of effort, $c(p)$, as a resource cost.

Furthermore, to capture the sensitivity of borrowing under uncertainty, we select different productivity variance parameter (σ) values and capture the relationship between the ratio of variable to total CEO pay and firm leverage.

Berger et al. (1997), and Carlson and Lazrak (2010) report that higher pay for performance sensitivity is associated with lower firm leverage. With a lower productivity variance parameter (i.e., when $\sigma = 0.10$), the variance of firm productivity, $V(\omega)$, will also be lower. There are two possible explanations behind this relationship. First, borrowing in order to expand a firm's operation requires a diversified end expert workforce. Unavailability of such a workforce may force the CEO to borrow less than her preference (e.g., Fama, 1980). Second, a lower productivity variance parameter (σ) value indicates the lack of any positive credit shock. Lack of a positive credit shock fails to protect the firms against loan defaults. Hence, the CEO prefers less than optimal leverage in order to shield herself from pressures associated with high debt volumes (e.g., Jensen, 1986). This is exactly what we find (see Panel A of Figure 2.6).

In the intermediate range (i.e., when $\sigma = 0.20$ and 0.40) of productivity variance parameter (σ) values, the CEO seems to shield herself from commitment to the lenders arising from high debt volumes in the low range of variable to total pay ratio. However, with a growing variable to total pay ratio, the possibility of a positive credit shock increases. This motivates the CEO to become more courageous and she aligns her interests with those of the shareholders and borrows more. Hence, we observe the U-shaped relationship (see Panels B and C of Figure 2.6).

Finally, Lewellen (2006) and Coles et al. (2006) document a positive relationship between risk taking proxied by firm leverage and pay for performance sensitivity. The CEO will have a tendency to borrow more when the productivity variance parameter is high (i.e., when $\sigma = 0.70$). A higher productivity variance parameter (σ) indicates a higher possibility of a positive credit shock which provides firms with protection against loan default. This encourages a CEO having higher variable pay to exert more effort towards firm growth.

However, since the firm's productivity shock is a function of the CEO's effort and the resulting cash flows are not known ex-ante (i.e., at date 0), the lender protects her own financial interest in case of default before lending. The probability of higher borrowing by the CEO is increasing in the ratio of variable to total CEO pay, and so does the chance of default. Hence, the CEO cannot borrow as she prefers. In fact, with higher variable to total pay ratio, both the lender and the shareholder exert stricter control on the debt level. Hence we observe a negatively concave relationship between a firm's leverage and variable to total CEO compensation. In other words, the CEO is not entrenched in the context of endogenous effort and hence her borrowing decisions are optimized (see Panel D of Figure 2.6).

Insert Figure 2.6 about here

We also capture the change in the relationship between endogenous CEO effort and variable to total pay ratio for a lower ($\sigma = 0.10$) and a higher ($\sigma = 0.70$) productivity variance parameter (see Panels A and B of Figure 2.7 respectively).

We find that in low risk firms, i.e., when the productivity variance parameter value (σ) is low, the CEO effort is increasing in the ratio of variable to total CEO pay (see Panel A of Figure 2.7). Low risk firms have a lower probability of default, thus the CEO feels encouraged to borrow more and she exerts more effort. On the other hand, for high risk firms, when the productivity variance parameter value (σ) is high, CEO effort has a negatively concave relationship with ratio of variable to total CEO pay (see Panel B of Figure 2.7). This occurs because the CEO does not feel motivated to exert more effort when faced with a stricter control on her borrowing level by the lender and the shareholder.

Insert Figure 2.7 about here

Existing empirical literature provides support to this conflicting relationship between firm risk and executive compensation. For example, Miller et al. (2002) propose a curvilinear relationship between firm risk and executive compensation. Furthermore, they also show that CEO total compensation increases with an increase in systematic firm risk. Other literature supporting this positive relationship include Lewellen et al. (1987), Core and Guay (2002), and Prendergast (2000). Another stream of literature shows no relation between idiosyncratic uncertainty and executive compensation (see Ittner et al., 1997; Conyon and Murphy, 1999). Finally, a negative relationship between idiosyncratic uncertainty and executive compensation is empirically shown in studies by Jin (2002) and Dee et al. (2005). Thus, existing empirical literature provide support to our argument that differences in CEO pay can be created by manipulating the productivity variance parameter (σ) (i.e., by varying the risk level).

CEO tenure is another important factor that affects the relationship between CEO effort and her variable to total pay ratio. A CEO with a long tenure will be more entrenched in a firm's decision making system and is more likely to pursue her own interests rather than those of the shareholders (Hill and Phan, 1991). Furthermore, a CEO with longer tenure can gain control over the board of directors and can consequently demand compensation packages that fulfill her own interests.

Several reasons exist to suggest that a CEO's influence over the board will increase with the duration of her tenure. First, CEOs are actively involved in selecting new board members (Herman, 1981; Vance, 1983). Hence, a CEO can start behaving like a dictator by replacing troublesome board members by the ones she prefers (Finkelstein and Hambrick, 1989). These newly elected board members will be loyal to the CEO rather than to the shareholders.

This level of control over the board members is highly improbable for a new CEO or a CEO with a shorter tenure. Fredrickson et al. (1988) argue that new CEOs are extremely vulnerable early in their tenures. In fact, "CEOs gain power over time as they gain voting control, establish a patriarchal aura, or co-opt the board of directors" (Fredrickson et al., 1988: 258). Second, a

CEO with long tenure will have influence over a firm's internal information system. This may restrict sharing of information "from compensation committees when that information would attribute poor firm performance to bad management" (Coughlan and Schmidt, 1985: 45). In addition, a long tenured CEO can use her control over information systems to select the agenda for the board meetings in a way that projects the CEO favorably (Hill and Phan, 1991)

Hence, the board of directors must play an active role to protect shareholders' interests against the interests of long serving CEOs.

2.4.5 The shareholder

The shareholder makes a take it or leave it offer to the potential CEO taking into account that the compensation contract will affect the CEO's effort and borrowings. Thus, the shareholder chooses the compensation contract (A, v) to maximize the firm's cash flow net of payments to the lender and to the CEO:

$$\max_{\{A, v\}} \int_{\hat{\omega}}^{\infty} \left[(1-v)\left(Y(\omega, K) - R_L B\right) - A\right] dF(\omega; p) \qquad 2.11$$

subject to the CEO's effort, default threshold and borrowings determined by the FOCs of the CEO's problem defined by Equation (2.10).

A larger debt expands the scope of the firm and can potentially lead to a larger cash flow. Thus, the shareholders motivate the CEOs by increasing the variable compensation when leverage increases. This is exactly what we find in Figure 2.8.

Insert Figure 2.8 about here

2.4.6 Calibration

Our goal in this paper is to do theory. However, since the model has no closed form solutions, we used parameter values from existing literature to solve the model numerically. Then we illustrate how changing these parameters would change the results. Specifically, we show how the predictions of the model change by varying a) productivity variance parameter (σ) and,

b) level parameter of effort (ψ). The rest of the model parameters come from the existing literature and changing them would not alter the main insights of the paper.

To solve the model numerically we assume that the CEO has the standard CRRA preferences:[29]

$$u(C) = \frac{C^{1-\eta}}{1-\eta}, \quad 2.12$$

where the CEO's consumption C is the wage payments $s(\omega)$ defined in Equation 2.8 minus the cost of effort, i.e.,

$$C = s(\omega) - c(p). \quad 2.13$$

The parameter η is the coefficient of risk aversion. For $\eta > 0$, $\eta \neq 1$ there is positive risk aversion. The risk-neutral case is $\eta = 0$.

We use the same coefficient of risk aversion (η) as Carlson and Lazrak (2010), the foreclosure cost parameter (γ) follows Bernanke et al. (1999), and the scale parameter (σ) of the lognormal productivity shocks is in the set of values common in the BGG literature (see Gete and Melkadze, 2018 for example). We also analyze the impact of credit supply expansion on changes in leverage across firms with different CEO compensation contracts. For this purpose we use the monetary stimulation implemented by China as our test case.[30] For the cost of lenders' funds (R_b) we use a 2% rate, which is the average return on deposits between 2007 and 2010 in China. We select the credit stimulus parameter (τ) to match the decrease in interbank rates that the Chinese Central Bank implemented in 2008. Table 2.1 contains the parameters of the model and Table 2.2 reports the moments that we match.

Insert Tables 2.1 and 2.2 about here

We show different productivity variance parameter (σ) values change the correlation between

[29] Calibration exercises with CRRA preferences include Dittmann et al. (2010) and, Hall and Murphy (2000) among others. We verified that the results also hold for constant absolute risk aversion (CARA) preferences. Given the strong intuition behind the theory, the results are also expected to hold for other preference types such as Epstein-Zin.

[30] The Chinese government announced a $568 billion stimulus package. This stimulus package was followed up by a drastic easing of monetary policy (Deng et al., 2015). This announcement was extensively covered by the media mostly focusing on the huge volume of the stimulus package.

CEO effort and the ratio of variable to total CEO pay. A low productivity variance parameter (σ) implies low risk. In a low risk scenario, the default probability is low. Consequently, the CEO feels more secured against any potential personal financial loss when she increases firm leverage. Hence, her effort to increase firm leverage is increasing in the ratio of variable to total pay for a low productivity variance parameter (σ). However, the rate of this increase is influenced by different CEO effort cost levels (represented by the level parameter of effort, ψ) (see Figure 2.5).

On the contrary, in a high risk scenario (i.e., for high productivity variance parameter, σ), the default probability is high, and the CEO feels a threat of potential personal financial loss as increasing firm leverage may cause a default. Hence, the CEO exerts less effort to increase firm leverage. This is exactly what we find in Figure 2.9, where we show that CEO effort is decreasing in the ratio of variable to total pay for a high productivity variance parameter (σ). In this case, the influence of different CEO effort cost levels (represented by the level parameter of effort, ψ) on the rate of decrease in CEO effort are pretty similar (see Figure 2.9).

Insert Figure 2.9 about here

Hence, Figures 2.5 and 2.9 suggest that the productivity variance parameter (σ) overpowers the CEO effort cost.[31]

2.5 Executive compensation and capital structure

First we analyze the sign of the correlation between leverage and variable compensation. Then we show some other predictions.

2.5.1 The sign of the correlation in the cross-section of firms

Figure 2.10 contains our key cross-sectional result. The top panel is a model with exogenous compensation, like Carlson and Lazrak (2010). The bottom channel is the model presented in Section 2.4 with endogenous compensation setup. The top panel shows a *negative* correlation

[31] The results remain almost same when other parameter values are varied.

between leverage and variable compensation. The bottom panel shows a *positive* correlation. Both cases are for a risk-averse CEO.

Insert Figure 2.10 about here

The top panel in Figure 2.10 shows that a compensation contract with a larger performance-based component discourages leverage for risk-averse CEOs. That is, the CEO trades off variable compensation and leverage because both increase the variance of her total compensation and her exposure to default risk. As discussed by Carlson and Lazrak (2010), this channel generates a *negative* cross-sectional correlation between leverage levels and variable compensation.

The bottom panel in Figure 2.10 shows that the cross-sectional correlation between leverage levels and variable compensation becomes *positive* when all variables are endogenous and optimally selected.[32]

Figure 2.11 shows that optimal compensation (represented by the solid red dot on the top of the surface) implies the use of both variable pay choice ($v > 0$) and fixed compensation $(A > 0)$. The variable CEO compensation enhances her effort and consequently, increases the firm value through increased borrowing. However, a higher variable pay can make the CEO more risk averse leading to under-investment. On the other hand, the fixed component of CEO payment makes the CEO insured against any potential loss to her own financial interest in case of an adverse productivity shock to the firm. Thus, the CEO becomes less risk averse. This encourages the CEO to borrow more to increase the firm's operations and to increase her effort to reduce the probability of any adverse productivity shock. Thus, the optimal compensation package with a risk averse CEO is a compensation structure with variable pay that is enough to motivate the CEO to provide costly effort and fixed pay sufficient enough to insure her self-financial interests and to encourage her risk taking.

[32] In the top panel of Figure 2.10 compensation is exogenous and thus we could compare firms with different variable compensation. However, in the bottom panel both leverage and compensation are endogenous. In this situation, to generate cross-sectional heterogeneity, the firms need to differ on some parameter. We focus on the productivity variance parameter (σ) to capture firm heterogeneity. This choice is motivated by the approach taken by Panousi and Papanikolau (2012). They show that higher firm risk lowers investment especially when a risk averse CEO has a high variable pay component.

Insert Figure 2.11 about here

Figure 2.12 shows that low idiosyncratic risk (represented by the productivity variance parameter, σ) also encourages CEO effort which, in turn, makes negative productivity shocks less likely. Thus, the CEO feels encouraged to increase firm leverage. Moreover the shareholders want higher variable compensation to motivate the CEO in firms with low idiosyncratic risk.

Insert Figure 2.12 about here

In this way, when we focus on firms with different productivity variance parameter (σ) values to generate cross-sectional heterogeneity, there are two channels at play. First, volatility is bad for lenders because debt contracts imply concave payoffs. That is, high risk firms have higher default risk. Second, volatile firms encourage less effort from their risk-averse CEOs. Thus, all things being equal, less volatile firms face lower borrowing costs and, as a consequence, CEOs of such firms will desire a higher level of leverage. Also, in a less volatile firm, the CEO faces less risk in his share of the firm's investment, so she is willing to exert more effort to the firm.

Thus, to recap, we just showed two channels that generate opposite predictions for the sign of the correlation between performance based compensation and firm leverage. Depending on what channel dominates the correlation can be positive or negative even if CEOs are risk-averse. This result explains why the empirical literature reports conflicting findings to explain the relationship between CEO compensation structure and firm leverage.

2.5.2 Other predictions

Figure 2.13 shows other novel predictions of the model: *total compensation* is increasing in leverage; and leverage and the ratio of variable to fixed compensation are *positively* correlated.

Insert Figure 2.13 about here

As we discussed before, firms with low productivity variance parameter (σ) will reward their CEOs with higher variable pay to motivate them to exert more effort (p). This is because the firms with low risk can get more low cost credit supply from the banks. As the leverage and CEO effort (p) are complementary, higher CEO effort will lead to an expansion of future cash flow for the firms. However, an increased variable pay can discourage a risk averse CEO from borrowing because of her personal financial concerns associated with the increased default probability. Thus, to encourage the CEO to borrow more, the shareholders of a low risk firm will also offer the CEO a higher fixed pay (see Panel A of Figure 2.13) to protect her financial interests. This will motivate the CEO to borrow more when the borrowing cost is low. In this way, the shareholders of a low risk firm will reward their CEO with both larger variable and fixed components and it will lead to larger total compensation (see Panel B of Figure 2.13). In addition, Panel C of Figure 2.13 shows that firm leverage is increasing in variable to fixed CEO compensation ratio for firms with low risk.

2.6 Credit stimulus, leverage and compensation

In this section, we show executive compensation structure as a crucial determinant of firm borrowing pattern given an increase in credit supply. We show that firms with a higher variable CEO pay (i.e., stronger incentives) borrow more. Understanding the reaction of the corporate sector to a large credit stimulus is crucial for both economists and policymakers. After all, one of the primary objectives for any credit stimulus is to increase retail and corporate borrowings.

2.6.1 Leverage growth during the credit stimulus

In our model we simulate the policy intervention by making the τ variable have a strictly positive value. This is consistent with Agarwal et al. (2018), who model credit expansions as changes in banks' cost of funds. The credit supply, which is the lender's participation constraint Equation 2.7, shifts right (Figure 2.A8 of Online Appendix) and the cost of leverage decreases when $\tau > 0$. Figure 2.14 illustrates the key cross-sectional implication of our model after the credit stimulus. The x-axis represents firms with different levels of CEO variable pay and the y-axis represents the growth of the leverage after a credit stimulus.[33]

[33] We assume that the compensation structure is exogenous right after the credit stimulus. For example there are short-term frictions to alter the compensation.

Insert Figure 2.14 about here

Figure 2.14 shows that firms whose CEOs have larger variable compensation react more to a credit supply shift. Thus, a CEO with high variable compensation will increase firm leverage more compared to another CEO with lower variable compensation. Intuitively, high variable pay implies that the CEO will share a larger portion of the rewards from leverage and is therefore more receptive to a credit stimulus. Thus, a higher variable compensation induces greater changes in leverage.

2.6.2 Optimal compensation after the credit stimulus

Now we study how the shareholders adjust the optimal CEO compensation structure after the government credit stimulus. When everything is endogenous, shareholders decide as in Figure 2.11. As before, to generate cross-sectional differences, we study firms with different productivity variance parameter (σ). Figure 2.15 contains the results.

Insert Figure 2.15 about here

Figure 2.15 shows that the optimal compensation structure including the CEO's variable pay, fixed pay, total compensation and variable to fixed compensation ratio all will increase after the credit stimulus. In addition, low risk firms will increase the variable pay, fixed compensation, total compensation and variable to fixed compensation ratio more than the other firms. Empirical studies such as Gilchrist et al. (2014) and, Stock and Watson (2012) have also explored the relationship between firm risk level and firm leverage.

The first driver of Figure 2.15 is that the investment opportunities and the CEO effort are complementary. After the credit stimulus, firms with low firm risk face better investment opportunities, so shareholders would like to reward the CEO with higher variable pay to motivate CEO to exert more effort to increase the cash flow for the firms (see Panel A of Figure 2.15). However, higher variable pay makes the CEO more conservative in borrowing. So, the shareholders also give the CEO higher fixed pay to offset the CEO's risk aversion. In this way, CEOs of firms with low idiosyncratic risk will also get more fixed pay after the credit push (see Panel B of Figure 2.15). As both the variable and the fixed pay increase after the credit stimulus, the total CEO compensation also increases more for the firms with low idiosyncratic risk (see Panel C of Figure 2.15). Fourth, while both the variable and fixed pay increase after the credit stimulus, the increased variable pay motivates the CEO to borrow more, and the fixed pay serves an auxiliary role in offsetting the CEO's personal financial risks. Hence, the variable to fixed compensation ratio increase faster for low risk firms (see Panel D of Figure 2.15). So, the shareholders reward the CEO with bigger compensation package to motivate her to borrow more while protecting her financial interest. This effect is greater in the firms with low idiosyncratic risk.

Our findings receive empirical support in the study by Chakraborti et al. (2021) who show the underlying mechanism for a positive relationship between executive compensation and firm leverage. They argue that this positive relationship is due to the fact that variable pay is a residual claim, while debt is a fixed claim. They also argue that both leverage and CEO compensation are endogenous. Thus, the optimal action of shareholders generates a positive cross-sectional relationship between firm leverage and the degree of pay for performance sensitivity (i.e., the variable component) of CEO compensation.

Since a credit stimulus increases the value of a firm, the CEO will borrow more if she is promised a larger share of the firm. In addition, after the credit stimulus, the variable component of CEO compensation increases as shareholders encourage their executives to borrow more to increase the firm value. Consequently, the CEO with high variable pay reaps the benefits of increase in firm value by borrowing more following a credit stimulus (Chakraborti et al., 2021).

2.7 Conclusions

This paper proposes a model with endogenous CEO compensation structure and firm leverage preferences. We show that this endogenous relationship can be explained using multiple channels. We also show that the cross-sectional relationships between firm leverage and variable component of CEO compensation remain ambiguous as found in existing literature.

Our model shows that the optimal CEO compensation structure is a combination of variable component enough to motivate the CEO to exert costly effort and a fixed component enough to protect the CEO's self-financial interest in case of an adverse shock to the firm, thus encouraging her to more risk taking. From the shareholders' perspective, firm leverage and the effort exerted by the CEO are complementary. Thus, to encourage higher CEO effort and CEO risk taking, optimal executive compensation packages must be increasing in firm leverage.

Finally, we show that the CEO compensation structure affects the credit demand. A crucial cross-sectional implication of our model is that firms with higher variable component of CEO pay will borrow more in response to a positive credit stimulus. Also, after the credit push, shareholders have the tendency to increase the size of the compensation package for the CEO. This increase is greater for these firms with low idiosyncratic risk. This increased compensation package also can make these firms more sensitive to future policy stimulus. This result uncovers a potential channel, which can play an important role in the effectiveness of credit policies. However, the unique economic structure of the Chinese economy makes it difficult to generalize the empirical findings to another economy.

2.8 Conclusiones

Este artículo estudia un modelo con contratos de compensación endógenos y opciones de apalancamiento. Mostramos que hay múltiples canales en juego y que los vínculos transversales entre el apalancamiento y la compensación variable son ambiguos y muy en línea con los hallazgos empíricos.

Nuestro modelo muestra que el paquete de compensación óptimo es una combinación de componentes fijos y variables que proporciona suficiente motivación para que un CEO ejerza un esfuerzo costoso y suficiente seguro para fomentar la asunción de riesgos. Desde la perspectiva del accionista, el apalancamiento y el esfuerzo del Consejero Delegado son complementarios. Por lo tanto, para fomentar estos dos elementos, los paquetes de compensación óptimos deben tener un pago total que aumente en el apalancamiento.

Finalmente, mostramos que la estructura de compensación del CEO afecta la demanda de crédito. Una implicación transversal clave que surge de nuestro modelo es que las empresas con una alta participación de los directores ejecutivos reaccionarán más (es decir, se endeudarán más) en respuesta a una expansión de la oferta de crédito. Además, después del impulso crediticio, los accionistas tienden a aumentar el tamaño del paquete de compensación para el director general. Este incremento es mayor para estas firmas con bajo riesgo idiosincrático. Este mayor paquete de compensación también puede hacer que estas empresas sean más sensibles a los futuros estímulos políticos. Este resultado descubre un canal potencial, que puede jugar un papel importante en la efectividad de las políticas crediticias. Sin embargo, la estructura económica única de la economía china dificulta la generalización de los hallazgos empíricos a otra economía.

2.9 Tables

Table 2.1: Parameters

Exogenously Determined			
Parameter	Value	Description	Source
η	1.1	Coefficient of risk aversion	Carlson & Lazrak (2010)
σ	0.40	Productivity variance parameter	Gete & Melkadze (2018)
γ	0.12	Foreclosure cost	Bernanke et al. (1999)
τ	0.01	Credit subsidy to lenders	Drop in Chinese interbank rates in 2008
R_b	1.02	Cost of lenders' funds	Mean return on Chinese deposits from 2007- '10
Endogenously Determined			
ψ	0.045	Level parameter of benefits from effort	
ε	0.315	Shape parameter of benefits from effort	
R_k	1.04	Parameter return of capital	
ϕ	0.0012	Level parameter of costs of effort	
ρ	2.2	Shape parameter of costs of effort	

Table 2.2: Model Moments

Description	Targets	Model
Leverage	0.50	0.50
Default rate	5.1%	5.57%
Lender lending rate	3%–6%	3.44%
Net ROA	4-6%	4%
Net ROE	7%–9%	8.47%

2.10 Figures

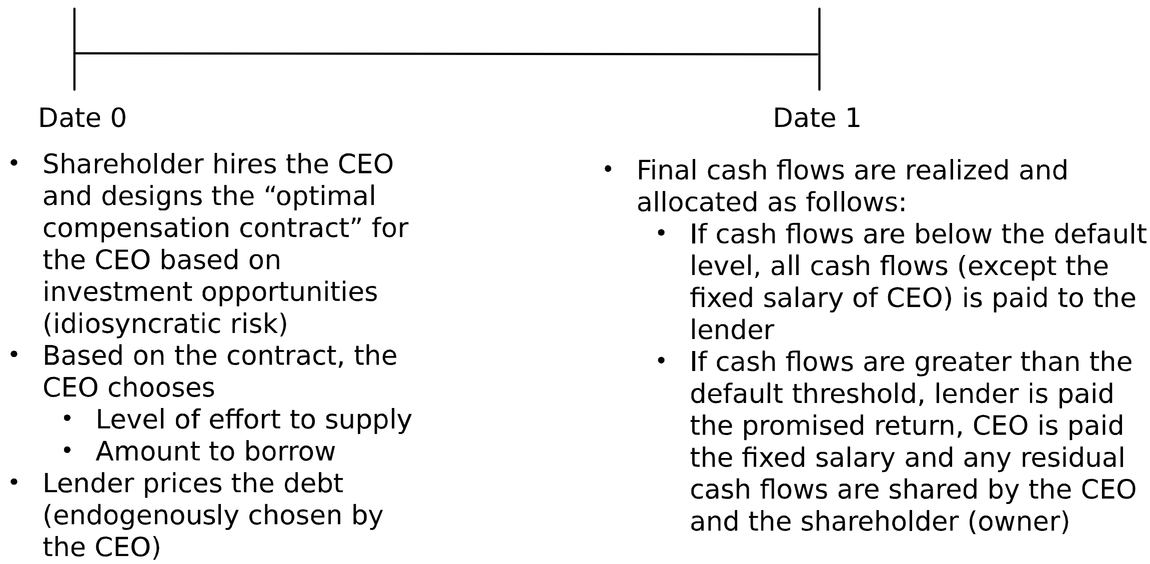


Figure 2.1. Time-line of the actions of shareholder, CEO and lender.

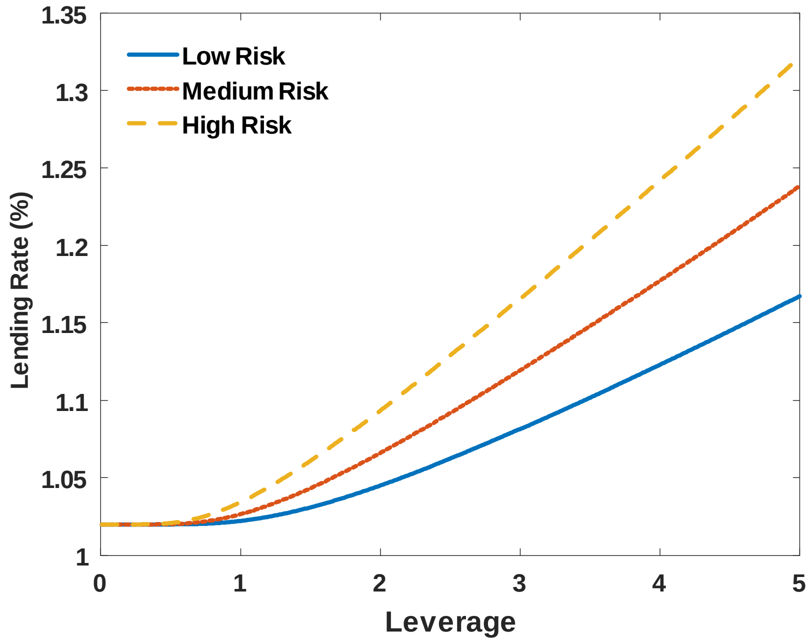


Figure 2.2. Lending rate and leverage. This figure plots the relationship between lending rates offered by the lenders and firm leverage for different productivity variance parameter (σ) values that represent different risk levels. The solid line represents the relationship between the lending rate and firm leverage for a low productivity variance parameter (i.e., $\sigma = 0.10$) when the risk is low. The dotted and the dashed lines represent the same relationship for a medium (i.e., $\sigma = 0.45$) when the risk is at a medium level and a high productivity variance parameter (i.e., $\sigma = 0.70$) when the risk is high, respectively.

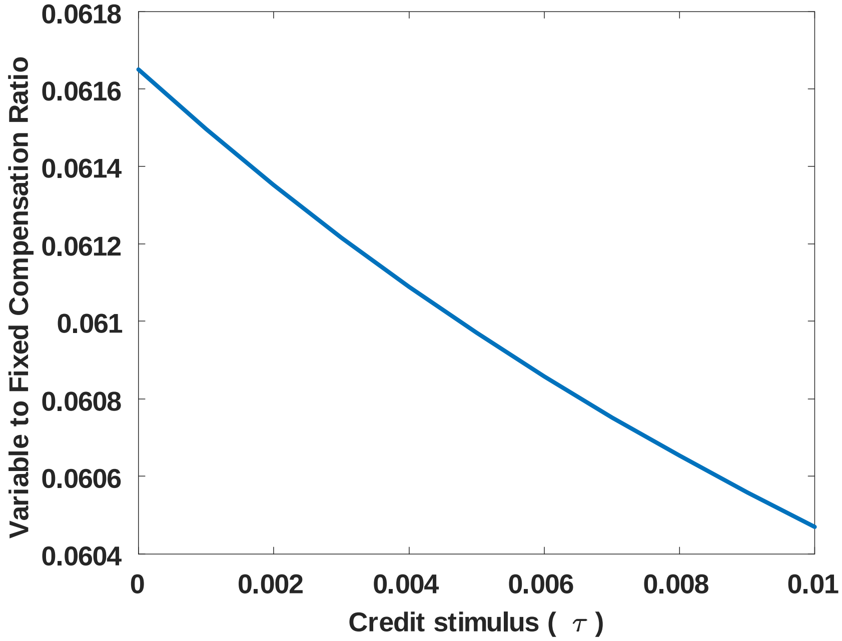


Figure 2.3. Variable to fixed CEO compensation and credit stimulus (τ). This figure plots the relationship between the credit stimulus (τ) and the variable to fixed CEO compensation ratio.

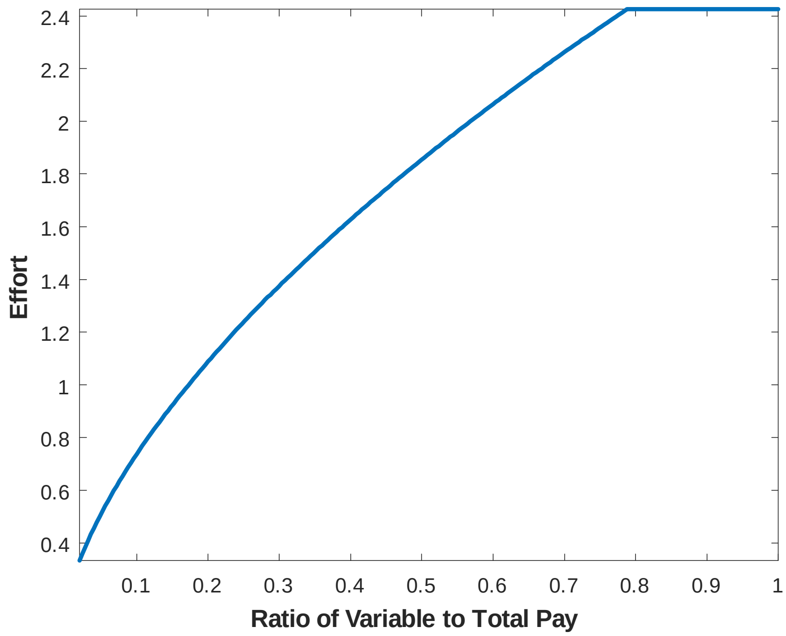


Figure 2.4. CEO effort and variable compensation. This figure plots CEO effort as a function of shareholder's choice of CEO's variable pay.

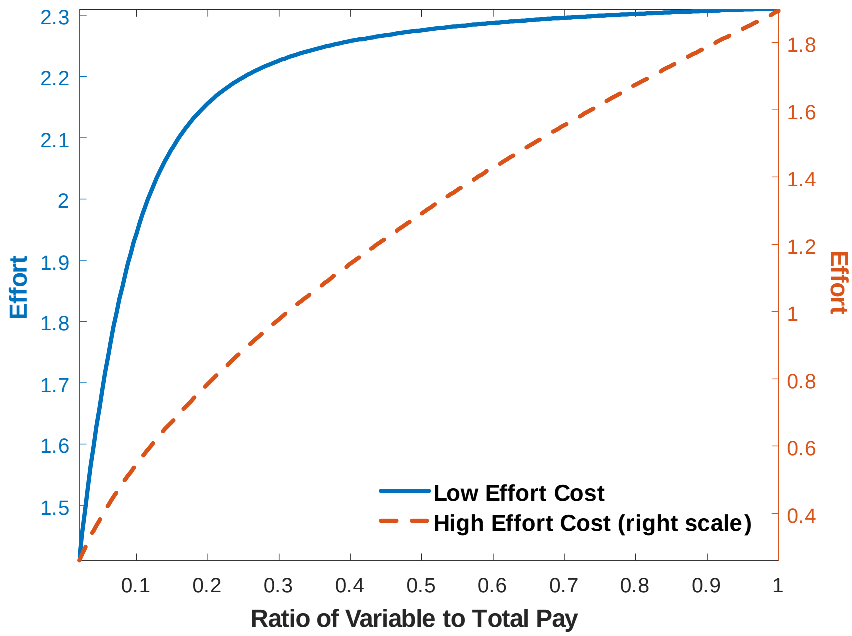


Figure 2.5. CEO effort and variable pay ratio for different effort costs ($\boldsymbol{\psi}$). This figure plots CEO effort as a function of shareholder's choice of the ratio of variable to total CEO pay for low and high CEO effort cost (captured by the level parameter of CEO effort, ψ). The solid line represents the relationship between the ratio of variable to total CEO pay and CEO effort when the cost of CEO effort is low (i.e., when $\psi = 0.01$). The dashed line represents the same relationship but when the cost of CEO effort is high (i.e., when $\psi = 0.06$).

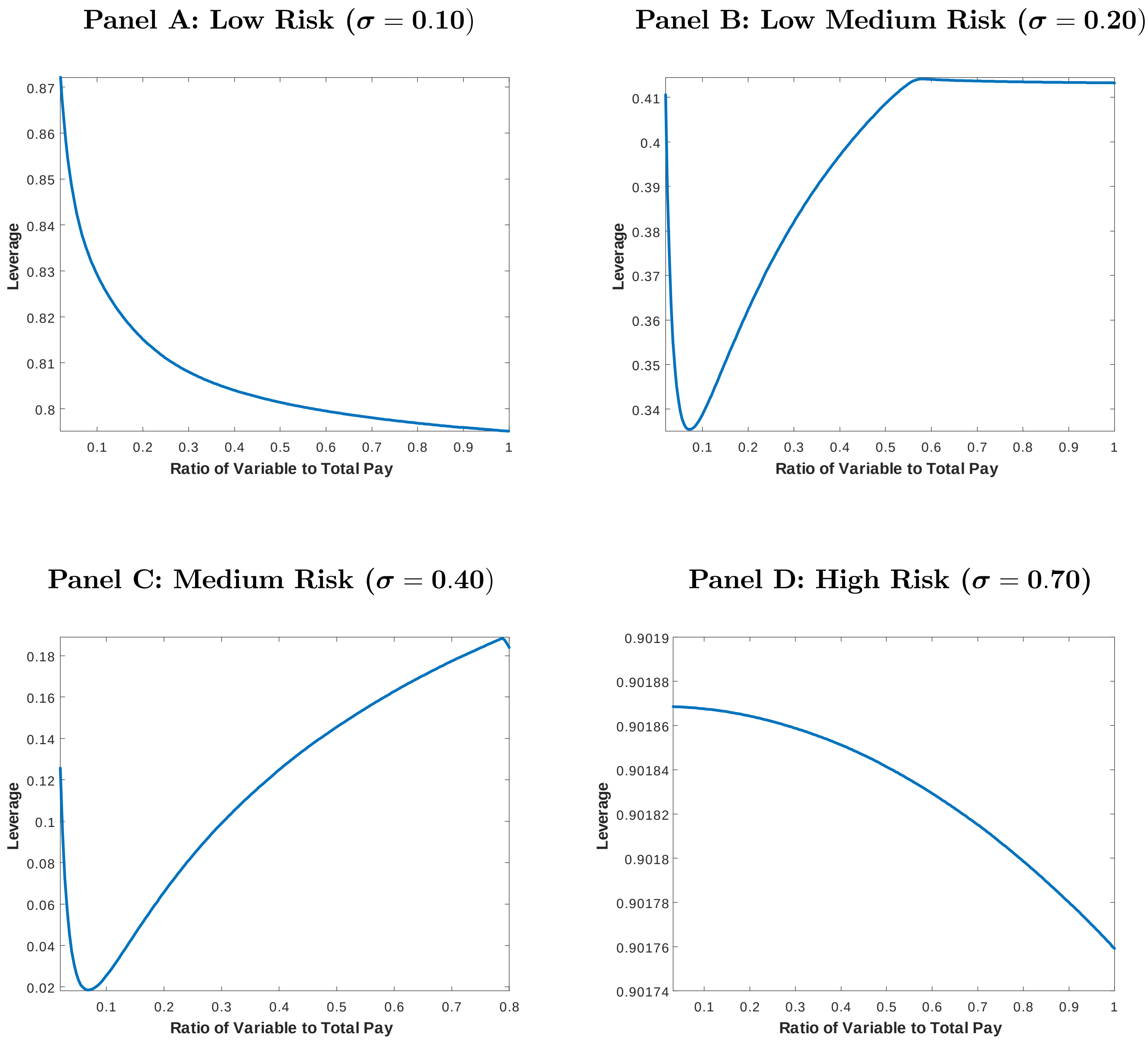


Figure 2.6. Leverage and variable pay ratio for different productivity variance parameter (σ). This figure plots the relationship between leverage and the ratio of variable to total CEO pay for firms for low (i.e., 0.10), low medium (i.e., 0.20), medium (i.e., 0.40) and high (i.e., 0.70) productivity variance parameter (σ) values.

Panel A: Low Risk ($\sigma = 0.10$) **Panel B: High Risk ($\sigma = 0.70$)**

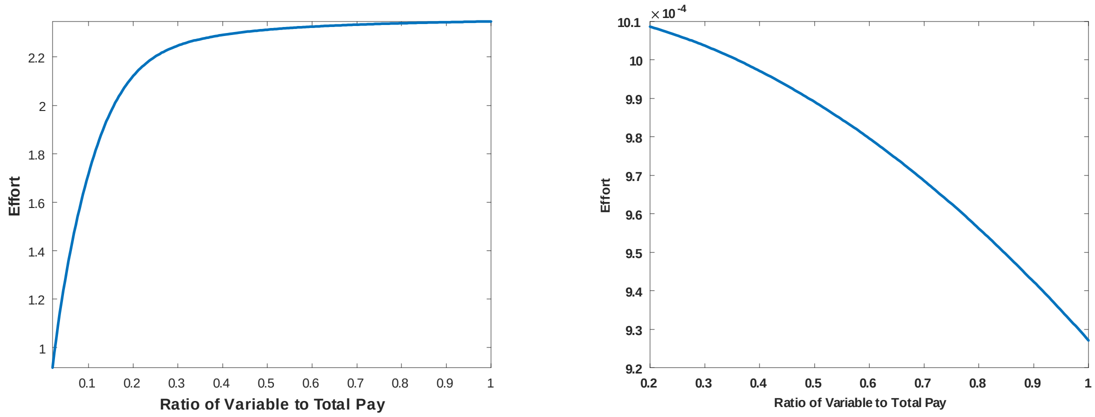


Figure 2.7. CEO effort and variable pay ratio for different productivity variance parameter (σ). This figure plots CEO effort and the ratio of variable to total CEO pay for firms with low (i.e., 0.10) and high (i.e., 0.70) productivity variance parameter (σ) values.

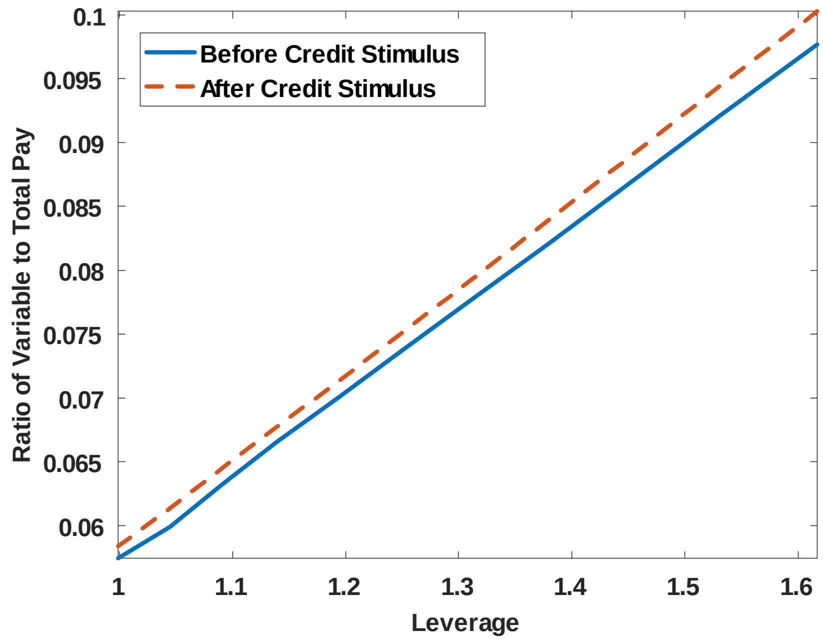


Figure 2.8. Leverage and variable pay ratio before and after credit stimulus. This figure plots the ratio of variable to total CEO pay as a function of firm leverage before and after a credit stimulus. The solid line represents the relationship between the ratio of variable to total CEO pay and firm leverage before the credit stimulus when the borrowing cost is high. The dashed line represents the same relationship but after the credit stimulus when the borrowing cost is low.

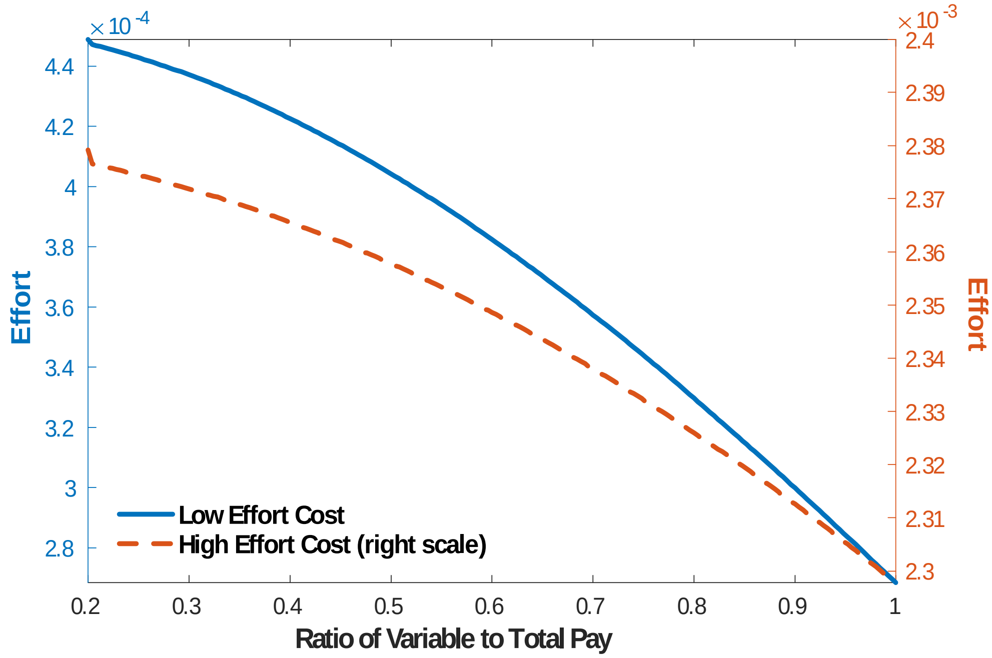


Figure 2.9. CEO effort and variable pay ratio for different CEO effort cost (ψ) for a high risk firm (σ). This figure plots the relationship between CEO effort and the ratio of variable to total CEO pay for high productivity variance parameter ($\sigma = 0.70$) value. The figure also captures CEO effort for low (i.e., 0.01) and high (i.e., 0.06) CEO effort cost captured by the level parameter of CEO effort (ψ).

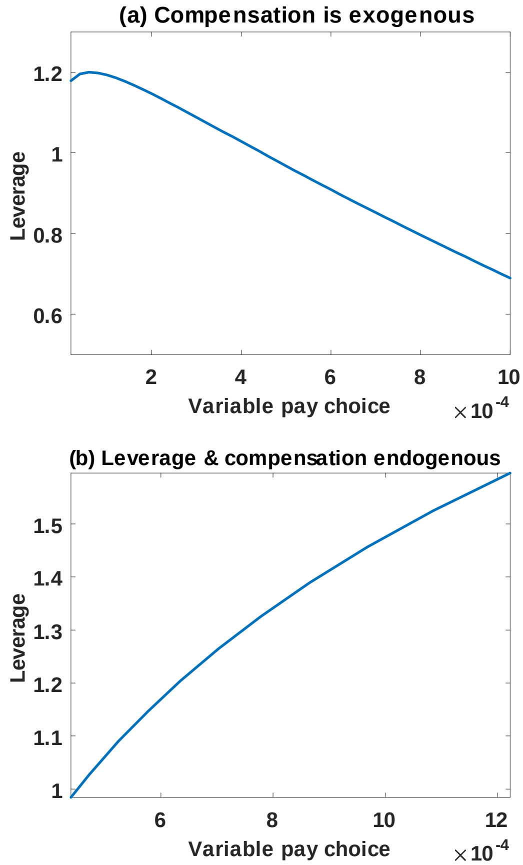


Figure 2.10. Leverage and variable compensation in models with exogenous or endogenous compensation. This figure plots firm's leverage as a function of shareholder's choice of CEO's variable pay (v). In the top panel, the compensation is exogenous. In the bottom panel the compensation is endogenous as in Section 2.3.3. For the endogenous compensation case, all variables change because the degree of productivity variance parameter (σ) is different across firms. Leverage is defined as debt-to-equity ratio ($\frac{B}{N}$).

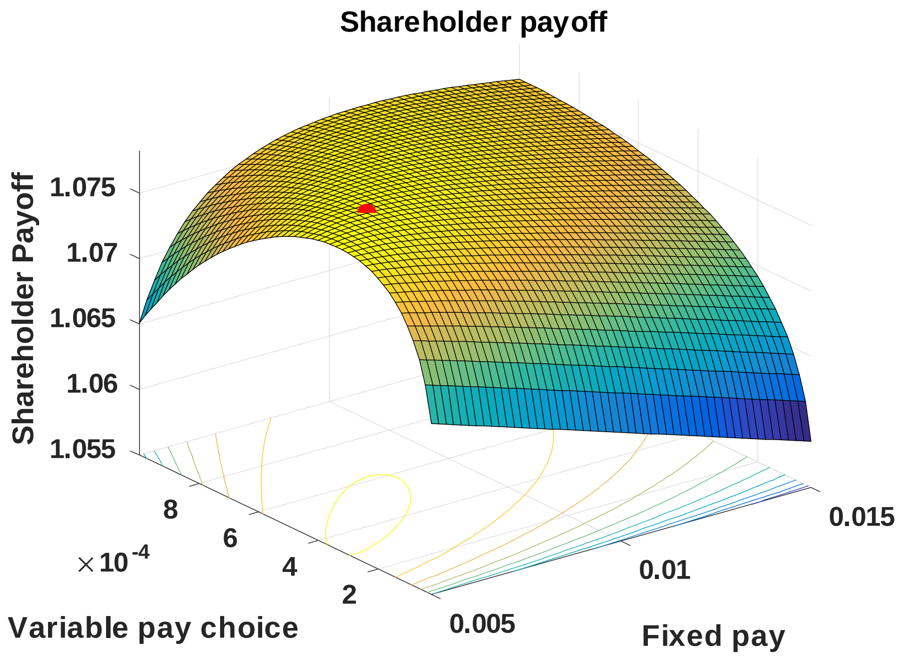


Figure 2.11. Shareholder payoff as a function of CEO compensation. This figure plots the shareholder's payoff (Equation 2.11) as a function of the variable (v) and fixed (A) compensations paid to the CEO. All parameters are as in Table 2.1. The optimal combination (v, A) is the dot on the top of the surface.

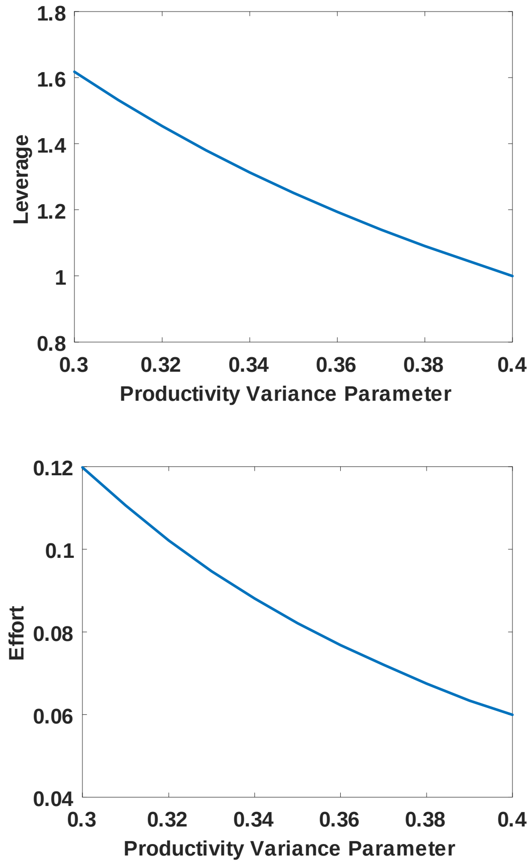


Figure 2.12. Leverage and CEO effort as a function of firm's risk (σ). This figure plots leverage (in Panel A) and CEO's effort (in Panel B) for firms with different levels of productivity variance parameter (σ).

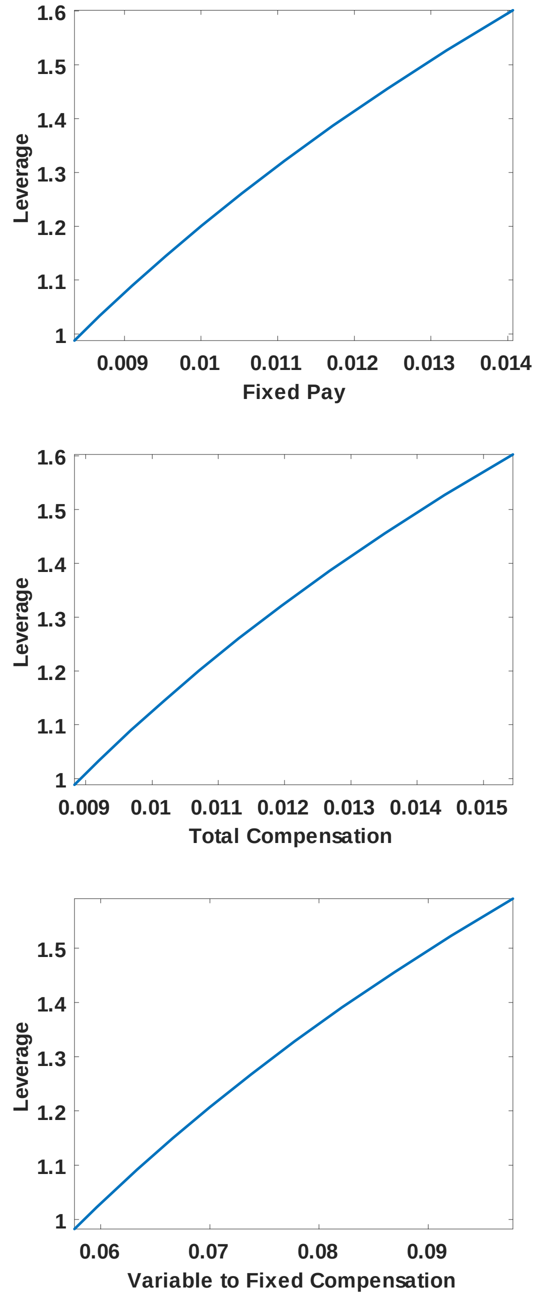


Figure 2.13. Compensation variables and leverage in the cross-section of firms. This figure plots the compensation variables versus the firm's leverage. All variables listed in this figure are endogenous as in Section 2.3. All variables change because the degree of productivity variance parameter (σ) is different across firms.

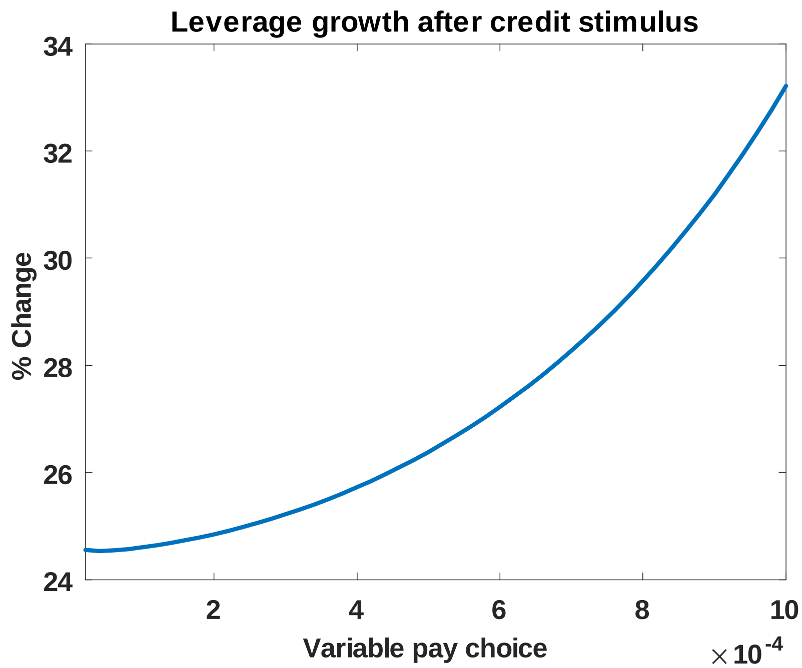


Figure 2.14. The effects of a credit stimulus on firm's leverage. This figure plots the % change in firm's leverage for firms with different level of variable compensation (v) after the simulated credit stimulus. Figure 2.A8 of Online Appendix shows how the credit stimulus change the credit supply.

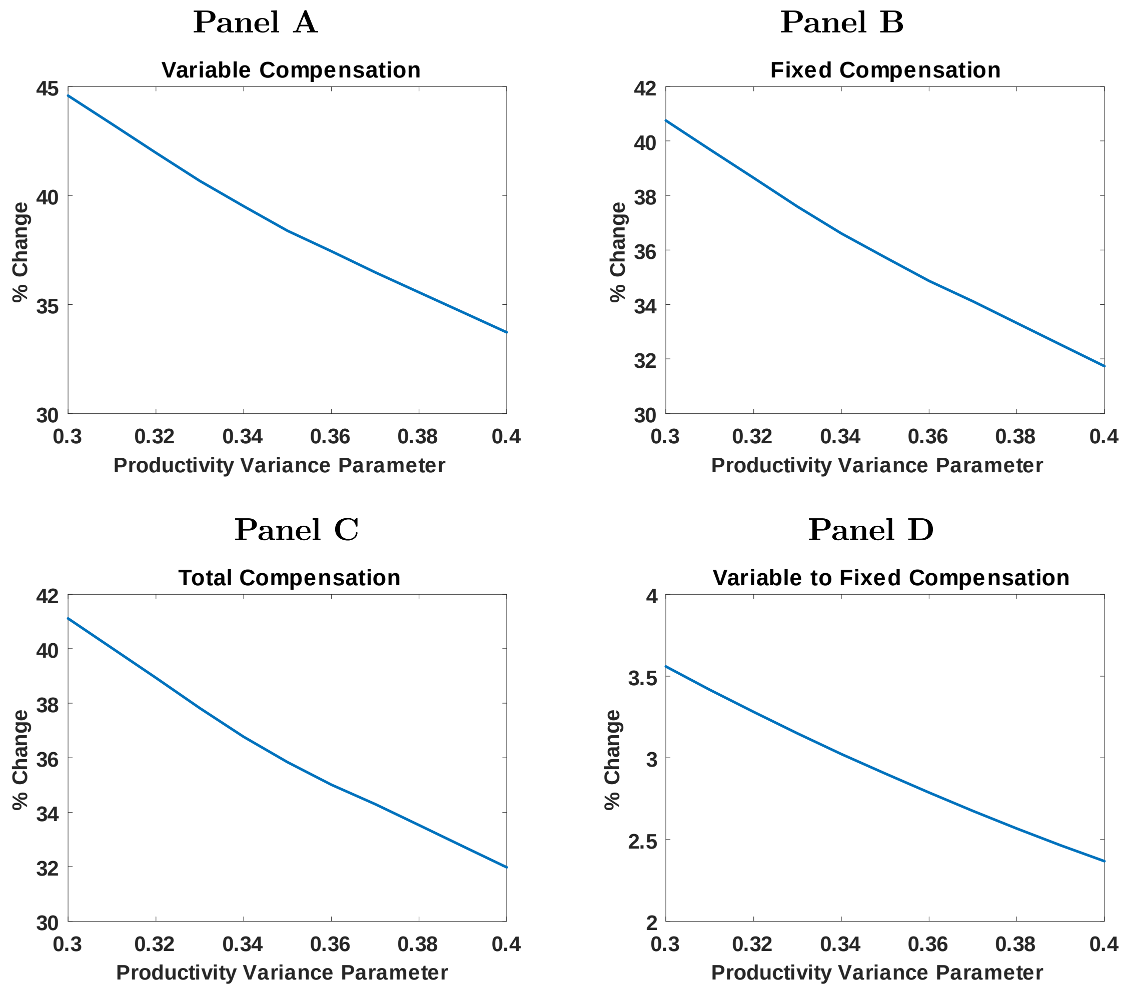


Figure 2.15. Change in compensation structure after the credit stimulus for different levels of firm risk (σ). This figure plots the percentage change in compensation variables and leverage after the credit stimulus for firms with different productivity variance parameter (σ) values.

ONLINE APPENDIX. NOT-FOR-PUBLICATION

2.11 The CEO problem

We denote the CEO's payoff when the firm is not in default as:

$$\Omega(\omega, \hat{\omega}, B, p) \equiv A + v\,(\omega - \hat{\omega})\, R^k(B+N) - c(p), \qquad 2.A1$$

and the CEO's payoffs when the firm is in default as:

$$\Psi(p) \equiv A - c(p). \qquad 2.A2$$

Using (2.A1) and (2.A2), the CEO's maximization problem (2.10) becomes:

$$\max_{\{\hat{\omega}, p, B\}} \int_{\hat{\omega}}^{\infty} u\left(\Omega(\omega, \hat{\omega}, B, p)\right) f(\omega; p)\, d\omega + u(\Psi(p))\, F(\hat{\omega}; p) \qquad 2.A3$$

s.t.

$$\int_0^{\hat{\omega}} (1-\gamma)\, \omega R^k(B+N) f(\omega; p)\, d\omega + \hat{\omega} R^k(B+N)\left(1 - F(\hat{\omega}; p)\right) = R^B(1-\tau)B. \qquad 2.A5$$

Denoting the Lagrangian multiplier by λ_m the Lagrangian is

$$\mathcal{L}_m(\hat{\omega}, p, B) = \left\{ \begin{array}{l} \int_{\hat{\omega}}^{\infty} u\left(\Omega(\omega, \hat{\omega}, B, p)\right) f(\omega; p)\, d\omega + u(\Psi(p))\, F(\hat{\omega}; p) + \\ +\lambda_m \left[\begin{array}{l} \int_0^{\hat{\omega}} (1-\gamma)\, \omega R^k(B+N) f(\omega; p)\, d\omega + \\ +\hat{\omega} R^k(B+N)\left(1 - F(\hat{\omega}; p)\right) - R^B(1-\tau)B \end{array} \right] \end{array} \right\},$$

and the FOCs are:

$$\frac{\partial \mathcal{L}_m(\hat{\omega}, p, B)}{\partial \hat{\omega}} = \left\{ \begin{array}{l} -\int_{\hat{\omega}}^{\infty} u'(\Omega) v R^k(B+N) f(\omega; p)\, d\omega + \\ +\lambda_m \left[-\gamma \hat{\omega} R^k(B+N) f(\hat{\omega}; p) + R^k(B+N)\left(1 - F(\hat{\omega}; p)\right) \right] \end{array} \right\} = 0. \qquad 2.A6$$

For effort:

$$\frac{\partial \mathcal{L}_m(\hat{\omega}, p, B)}{\partial p} = \left\{ \begin{array}{l} \int_{\hat{\omega}}^{\infty} \left[-u'(\Omega)c'(p)f(\omega;p) + u(\Omega)\frac{\partial f(\omega;p)}{\partial p} \right] d\omega + \\ +u(\Psi)\frac{\partial F(\hat{\omega};p)}{\partial p} - u'(\Psi)c'(p)F(\hat{\omega};p) + \\ +\lambda_m \left[\begin{array}{l} \int_0^{\hat{\omega}} (1-\gamma)\omega R^k (B+N) \frac{\partial f(\omega;p)}{\partial p} d\omega + \\ -\hat{\omega} R^k (B+N) \frac{\partial F(\hat{\omega};p)}{\partial p} \end{array} \right] \end{array} \right\} = 0, \qquad 2.A7$$

and for debt level:

$$\frac{\partial \mathcal{L}_m(\hat{\omega}, p, B)}{\partial B} = \left\{ \begin{array}{l} \int_{\hat{\omega}}^{\infty} u'(\Omega)(\omega - \hat{\omega}) v R^k f(\omega;p)\, d\omega + \\ +\lambda_m \left[\begin{array}{l} \int_0^{\hat{\omega}} (1-\gamma)\, \omega R^k f(\omega;p)\, d\omega + \\ +\hat{\omega} R^k \left(1 - F(\hat{\omega};p)\right) - R^B(1-\tau) \end{array} \right] \end{array} \right\} = 0. \qquad 2.A8$$

2.12 The shareholder's problem

The shareholder proposes the compensation contract $\{v, A\}$ that maximizes

$$\max_{\{v,A\}} \int_{\hat{\omega}(v,A)}^{\infty} \left[(1-v)(\omega - \hat{\omega}(v,A))R_k(B(v,A)+N) - A\right] f(\omega; p(v,A))\, d\omega, \qquad (1)$$

subject to the CEO's decision allocations $\hat{\omega}(v, A)$, $p(v, A)$ and $B(v, A)$ implicitly defined in Section 2.A1. That is, the shareholder solves:

$$\max_{\{v,F,\hat{\omega},p,B\}} \int_{\hat{\omega}}^{\infty} \left[(1-v)(\omega - \hat{\omega})R_k(B+N) - A\right] f(\omega;p)\, d\omega, \qquad (2)$$

subject to the first order conditions of the CEO's problem of functions (2.A6), (2.A7) and (2.A8). We use a numerical method to solve the shareholders' problem.

2.13 Empire building CEO

We now provide a comparison of effort and borrowing behavior between an empire building and a non-empire building CEO.

For a non-empire building CEO, the payoffs are:

$$s(\omega) = \begin{cases} A + v\left[Y\left(\omega, K\right) - R_L B\right] & \text{if} \quad \omega \geq \hat{\omega}, \\ A & \text{if} \quad \omega < \hat{\omega}. \end{cases} \tag{2.A9}$$

where, A is the fixed component and $0 \leq v \leq 1$ is the variable component of CEO compensation. However, for an empire building CEO, the payoffs are:

$$s(\omega) = \begin{cases} A + \varsigma(K) + v\left[Y\left(\omega, K\right) - R_L B\right] & \text{if} \quad \omega \geq \hat{\omega}, \\ A & \text{if} \quad \omega < \hat{\omega}. \end{cases} \tag{2.A10}$$

where the CEO's empire building attitude is captured through $\varsigma(K)$, which is a concave function of firm size. That is, the CEO enjoys leading a large firm:

$$\varsigma(K) = \nu K^{\kappa} \tag{2.A11}$$

where, $\nu > 0$ and $0 < \kappa < 1$.

We compare the relationship between leverage and ratio of variable to total CEO pay for empire building CEO and non-empire building CEO for low (i.e., $\sigma = 0.10$), low medium (i.e., $\sigma = 0.20$), medium (i.e., $\sigma = 0.40$) and high (i.e., $\sigma = 0.70$) productivity variance parameter values in Figure 2.A1. We find that irrespective of the value of the productivity variance parameter (σ), the relationship between leverage and ratio of variable to total CEO pay is always positively concave for the empire building CEO (see the dotted lines across all panels of Figure 2.A1). However, the relationship between leverage and ratio of variable to total CEO pay depends on the productivity variance parameter (σ) values for the non-empire building CEO (see the solid lines across all panels of Figure 2.A1). We provide a detailed discussion behind such variation in the relationship between leverage and ratio of variable to total CEO pay for a non-empire building CEO in Section 2.4.4.

Insert Figure 2.A1 about here

These findings suggest that an empire building CEO overpowers any attempt to control her borrowing by the shareholders and the lenders, which a non-empire building CEO fails to do.

2.14 Lognormal distribution as the preferred choice

In our model, ω represents the productivity shock of a specific firm while R_K is the aggregate return to capital. The firm's cash flow (Y) at date 1 is stochastic and depends both on the capital employed (K) and on the productivity shock (ω). The firm's cash flow is given as:

$$Y(\omega; K) = \omega R_K K$$

Where, ω is the productivity shock and $R_K K$ is the ex-post aggregate return to a firm's capital. We assume that the productivity shock (ω) is idiosyncratic for firms over time. We also assume that the productivity shock (ω) has a continuous and once differentiable cumulative density function $F(\omega; p)$. We stress that the expected value of the productivity shock (ω) is a function of the CEO's effort (p) as given by Equation 2.4 and is reproduced below:

$$\mathbb{E}\left[\omega\right] = e^{\mu(p)+\frac{\sigma^2}{2}} = e^{\psi p^{\varepsilon}}$$

Further, we restrict the hazard rate, $h(\omega)$, for the productivity shock (ω) so that:

$$\frac{\partial(\omega h(\omega))}{\partial\omega} > 0$$

Where, $h(\omega) = \frac{F(\omega;p)}{1-F(\omega;p)}$. This regularity condition is a weak condition that satisfies almost all of the conventional distributions, including lognormal distribution.

Furthermore, since the expected value of the productivity shock (ω) is a function of the CEO's effort (p) (see Equation 2.4 of the revised draft), the cumulative density function $F(\omega; p)$ is concave and increasing. This is also a characteristic of a lognormal distribution.

Hence, the use of lognormal distribution in our model assumptions is justified.[34]

2.15 CEO compensation in terms of share and cash

Equation 2.10 (reproduced below as Equation 2.A12) captures how a non-empire building CEO maximizes her utility:

$$\max_{\{\hat{\omega},p,B\}} \int_{\hat{\omega}}^{\infty} u\left(A + v\left(Y\left(\omega, K\right) - R_L B\right) - c(p)\right) dF(\omega;p) + \int_{0}^{\hat{\omega}} u\left(A - c(p)\right) dF(\omega;p) \qquad \text{2.A12}$$

subject to the lender's participation constraint that ensures that the CEO can borrow.

To address the concern of actual and immediate results in terms of cash rewards for the CEO's efforts, we modify Equation (2.A12) slightly. We propose that while putting in effort, the CEO expects a certain percentage ($0 < \beta < 1$) as cash reward and the remaining percentage (i.e., $1 - \beta$) in terms of improved equity values. Thus, the CEO wants to maximize her utility related to both cash reward and in terms of future equity values. Thus, we rewrite Equation (2.A12) as:

$$\max_{\{\hat{\omega},p,B\}} [\beta[\int_{\hat{\omega}}^{\infty} u\left(A + v\left(Y\left(\omega, K\right) - R_L B\right) - c(p)\right) dF(\omega;p) + \int_{0}^{\hat{\omega}} u\left(A - c(p)\right) dF(\omega;p)] + $$
$$+ (1-\beta) Y(\omega, K)] \qquad \text{2.A13}$$

Using Equation 2.A13, we investigate the relationship between CEO effort and the ratio of variable to total CEO pay and the results are given in Figure 2.A2. We also investigate the relationship between the ratio of variable to total CEO pay and firm leverage and the results are given in Figure 2.A3.

[34] Our approach is similar to the one by Bernanke et al. (1999) who assume that the productivity shock (ω) follows a lognormal distribution.

Insert Figures 2.A2 and 2.A3 about here

We find that irrespective of the CEO's expected cash reward percentage (i.e., β), CEO effort is increasing in the ratio of variable to total CEO pay (see Figure 2.A2). We also find that irrespective of the CEO's expected cash reward percentage (i.e., β), firm leverage has a negatively concave relationship with the ratio of variable to total CEO pay (see Figure 2.A3).

These findings suggest that CEO effort is increasing in expected cash reward percentage (i.e., β), but the lender and the shareholder use their control mechanism to restrict excessive borrowing by the CEO. However, we use a single period model in which the equality of a firm value and the final cash flow is a standard assumption (e.g., Liu et al., 2002).

2.16 CEO effort and firm leverage complementarity

To ensure optimum CEO effort, the shareholders must take into consideration individual risk factors that a CEO considers before exerting any effort to increase firm leverage. For example, a large, fixed CEO compensation, especially in a high-risk firm, may reduce the CEO's incentive to pursue strategies that maximize stock returns (Hill and Phan, 1991). On the contrary, offering a low fixed compensation may not be enough for the CEO to overcome her personal financial risks, leading to a lower than optimum firm leverage. To ensure the willingness of the CEOs to put in more effort to increase shareholders' wealth, different strategies are utilized. For example, shareholders can create complementarity between CEO effort and firm leverage by offering a "signing bonus" or a "golden parachute" to the CEO along with a higher fixed pay (Singh and Harianto, 1989), especially after a credit stimulus (see Figure 2.A4).

Insert Figure 2.A4 about here

Figure 2.A4 provides support to one of our original predictions that an optimal CEO compensation contract must contain a fixed component that is increasing in firm leverage. Figure 2.A4 also shows that the fixed component of CEO compensation is higher after a credit stimulus (see the dotted line) relative to pre-credit stimulus scenario (see the solid line) irrespective of

firm leverage level. This occurs because the borrowing cost decreases after a credit stimulus. Thus, the shareholders see the opportunity to grow and motivate the CEO to borrow more to enhance the scope of the firm's operations. To encourage the CEO to increase firm leverage, the shareholders must prepare a CEO contract that contains a higher level of fixed compensation component relative to the one offered in the absence of a credit stimulus. This protects the CEO against any personal financial loss in case of a default and she borrows more. This is exactly what Figure 2.A4 shows.

Shareholders prefer a relatively a strong link between CEO variable compensation and firm performance, and a weak link between absolute compensation and risk (Hill and Phan, 1991). Linking CEO variable compensation to firm performance is beneficial for the shareholders as this gives CEOs an incentive to create wealth for shareholders (Grossman and Hart, 1983). We assume that from a shareholder's perspective, her wealth will increase only when the firm grows, and this growth of firm depends on the amount of effort the CEO is willing to exert to borrow more.

Offering fixed incentives takes away the individual financial risk factors for a CEO and she aligns her own interests to those of the shareholders and consequently exerts more effort in order to ensure firm growth by borrowing more. This is exactly what we show in Figure 2.A5.

Insert Figure 2.A5 about here

As predicted, Figure 2.A5 shows that CEO effort is increasing in firm leverage irrespective of the presence of a credit stimulus. However, Figure 2.A5 also shows that the CEO has a higher effort level post credit stimulus (see the dotted line) relative to her effort level before the credit stimulus (see the solid line) across different leverage levels. This occurs as after a credit stimulus the borrowing cost decreases. Thus, the CEO is more motivated to exert effort to increase borrowing in order to enhance the scope of the firm's operations after a credit stimulus.

2.17 Idiosyncratic volatility and CEO effort

Firm volatility causes uncertainty regarding stock returns. This uncertainty is a personal financial risk that a CEO may not be willing to take. In fact, there are two reasons why, given a choice, a risk-averse CEO will not link her compensation to stock returns. First, a CEO may sacrifice stock returns in favor of firm growth (Aoki, 1980; Jensen, 1988). Any relationship between her compensation and stock returns limits the CEO's ability to trade stock returns for firm growth without harming her self interest.

Second, a link between CEO compensation and stock returns makes her own financial interest vulnerable to factors that are beyond her control. These factors include aggregate demand, overall stock market performance, inflation, and interest rates. Under such scenarios, a risk-averse CEO will not be willing to exert optimum effort to increase shareholders' wealth.

On the other hand, a higher uncertainty (proxied by the productivity variance parameter, σ) contracts credit supply. The borrowing firm's income becomes more uncertain with increase in the level of risk causing a higher default probability (Gete and Melkadze, 2018). In debt contracts, lenders' payoffs generally have a concave relationship to borrower's income. Therefore, a higher uncertainty (σ) decreases the lenders' potential revenue. Thus, for the same leverage ratio, lenders offer more expensive credit to volatile firms in order to compensate for the higher default risk (see Figure 2.2).

Therefore, in a situation with higher uncertainty (σ), a risk averse CEO will avoid putting more effort when she has a higher variable compensation component (see Panel B of Figure 2.7). This lack of CEO effort happens for two reasons. First, the CEO will not be keen to borrow more when the default risk is high. Second, credit becomes more expensive when the default risk is high. A more expensive credit will restrain the CEO to borrow more and hence, she will not be motivated to put in extra effort to expand the firm's operations.

To overcome this negative impact of firm and aggregate volatilities on CEO's effort, the shareholders should offer the CEO both a higher fixed pay and a higher total pay. This is exactly what we find in Figures 2.A4 and 2.A6 respectively. Such a compensation structure will help the CEO to overcome any potential risks to her self interest and she will exert more effort to align her interests with those of the shareholders. This argument finds support in the empirical work of Chakraborti et al. (2021).

Insert Figure 2.A6 about here

2.18 CEO variable compensation and social welfare

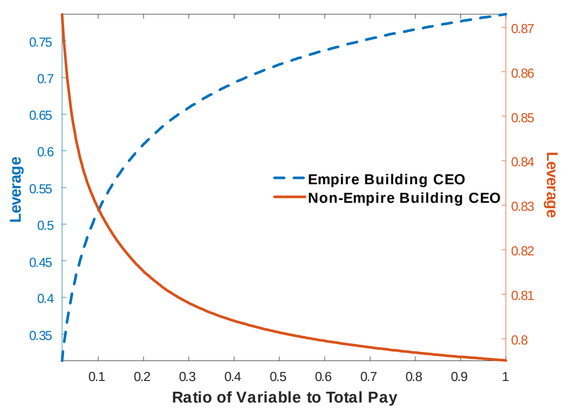
With positive credit shocks, like a credit stimuli, CEOs feel motivated to overinvest in excessively risky strategies due to lower borrowing costs. Lenders' undertake strict monitoring to prevent overinvestment in such risky strategies by eliminating CEO's pay for performance incentives (Kolm et al., 2015). To control for risky CEO overinvestment, lenders charge a higher lending rate that is increasing in both leverage and in the productivity variance parameter (σ) (see Figure 2.2). Furthermore, as the borrowing becomes more expensive with growing uncertainty, the CEO feels restrained in her borrowing and does not exert her full effort (see Figure 2.A7). Nevertheless, in presence of a credit stimulus, the CEO is more motivated than a scenario when no such stimulus exists. Thus, the CEO effort level is always higher in the presence of the credit stimulus (see the dotted line in Figure 2.A7) relative to the scenario when the credit stimulus is absent (see the solid line in Figure 2.A7).

Insert Figure 2.A7 about here

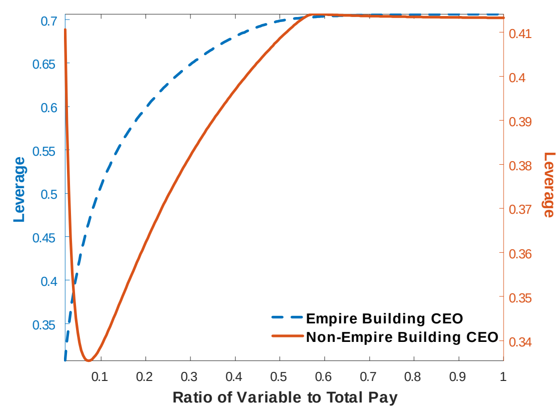
Therefore, optimal control on CEO decisions for firms combines strict monitoring and leverage constraint.

2.19 Extra Figures

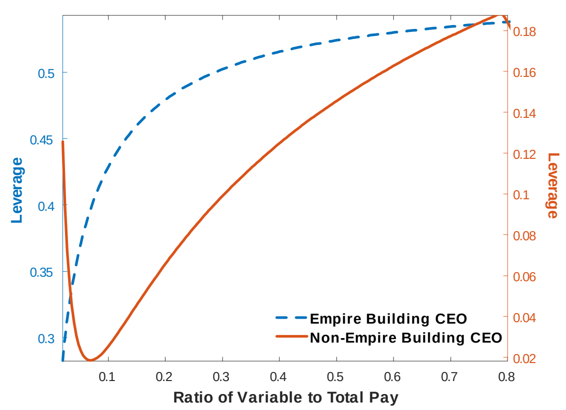
Panel A: Low Risk ($\sigma = 0.10$)



Panel B: Low Medium Risk ($\sigma = 0.20$)



Panel C: Medium Risk ($\sigma = 0.40$)



Panel D: High Risk ($\sigma = 0.70$)

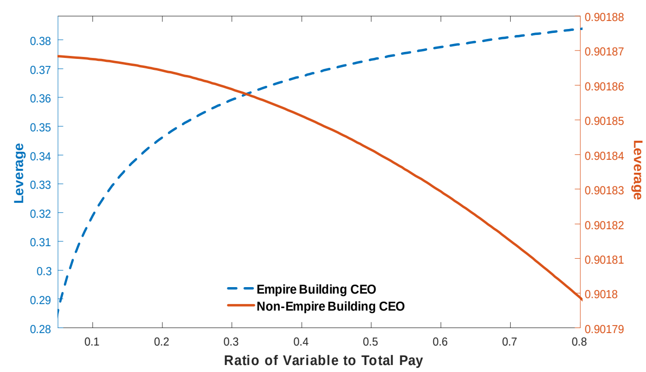
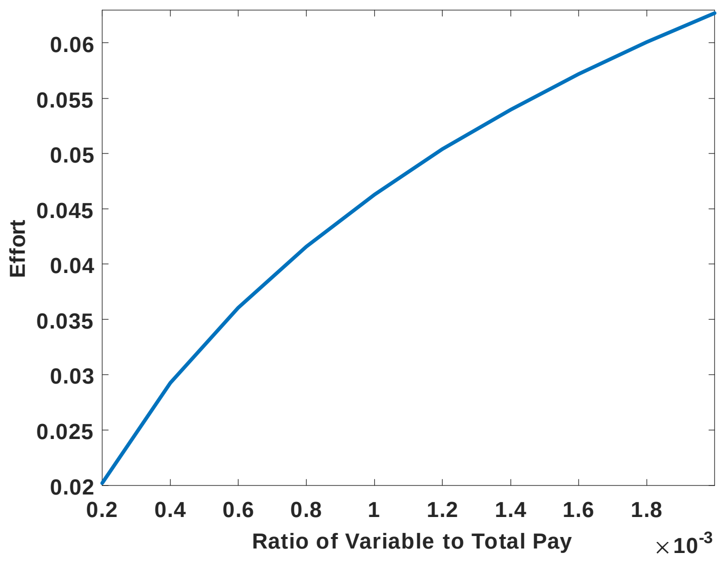


Figure 2.A1. Leverage and variable pay ratio for different CEO types and different levels of firm risk (σ). This figure plots firm leverage and ratio of variable to total CEO pay for firms with low (i.e., 0.10), low medium (i.e., 0.20), medium (i.e., 0.40) and high (i.e., 0.70) productivity variance parameter (σ) values for empire building and non-empire building CEOs. The dashed line represents the relationship between leverage and ratio of variable to total CEO pay for the empire building CEO. The solid line represents the same relationship but for the non-empire building CEO.

Panel 1: Low Cash Reward ($\beta = 0.10$)



Panel 2: High Cash Reward ($\beta = 0.70$)

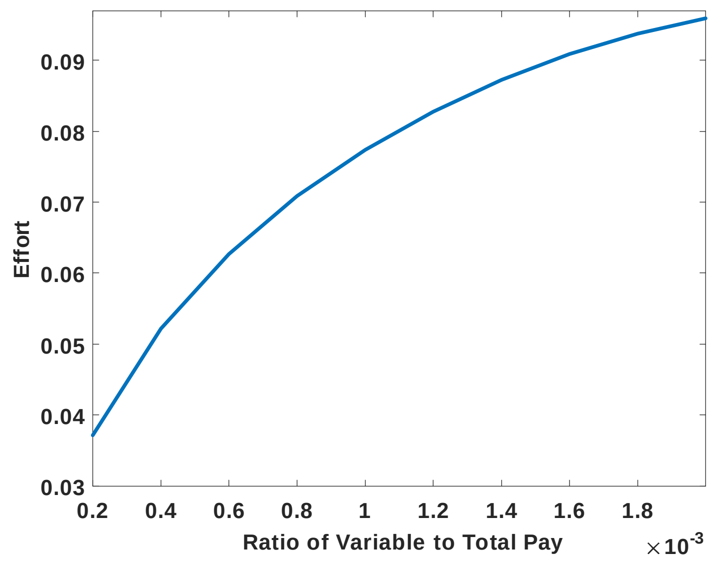
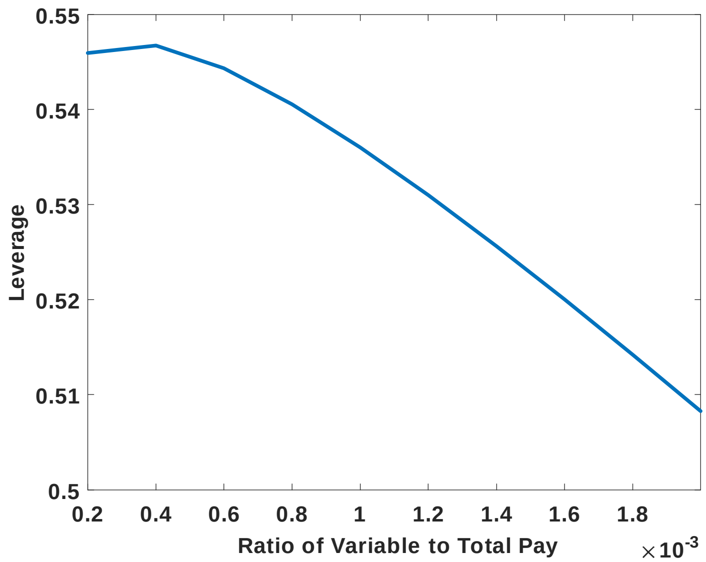


Figure 2.A2. CEO effort and variable pay ratio with different levels of cash reward expectations (β). This figure plots CEO effort for different ratios of variable to total CEO pay with low (i.e., 0.10) and high (i.e., 0.70) expected cash reward (β) values.

Panel 1: Low Cash Reward ($\beta = 0.10$)



Panel 2: High Cash Reward ($\beta = 0.70$)

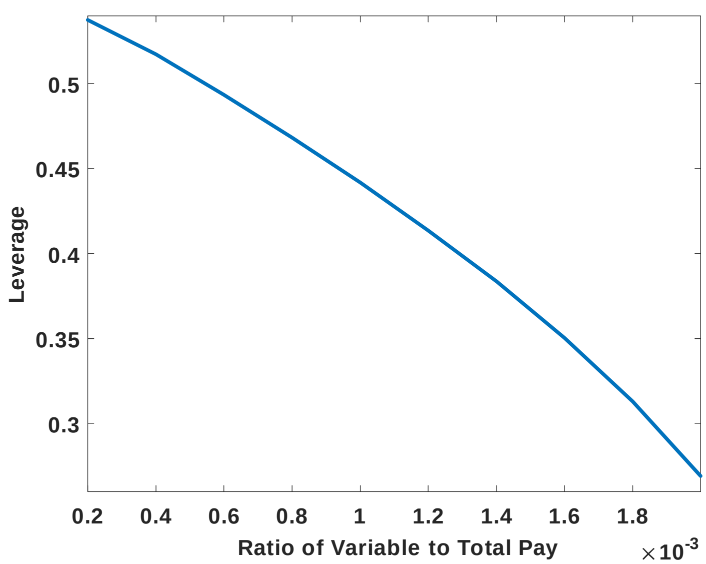


Figure 2.A3. Leverage and variable pay ratio with different levels of cash reward expectations (β). This figure plots firm leverage for a range of ratio of variable to total CEO pay with low (i.e., 0.10) and high (i.e., 0.70) expected cash reward (β) values.

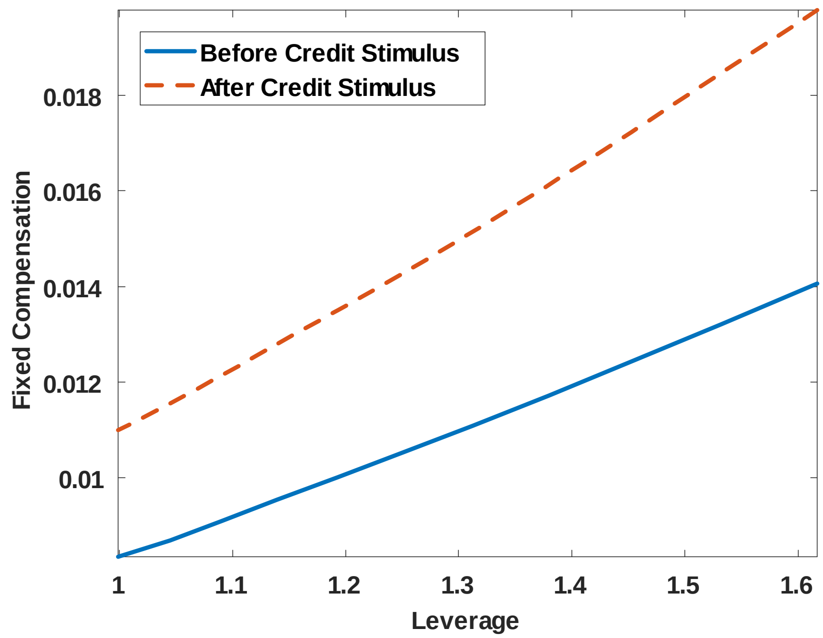


Figure 2.A4. Leverage and fixed CEO compensation. This figure plots firm leverage and fixed CEO compensation before and after a credit stimulus. The solid line represents the relationship between leverage and fixed CEO compensation before the credit stimulus when the borrowing cost for the firm is high. The dashed line represents the same relationship but after the credit stimulus when the borrowing cost for the firm is low.

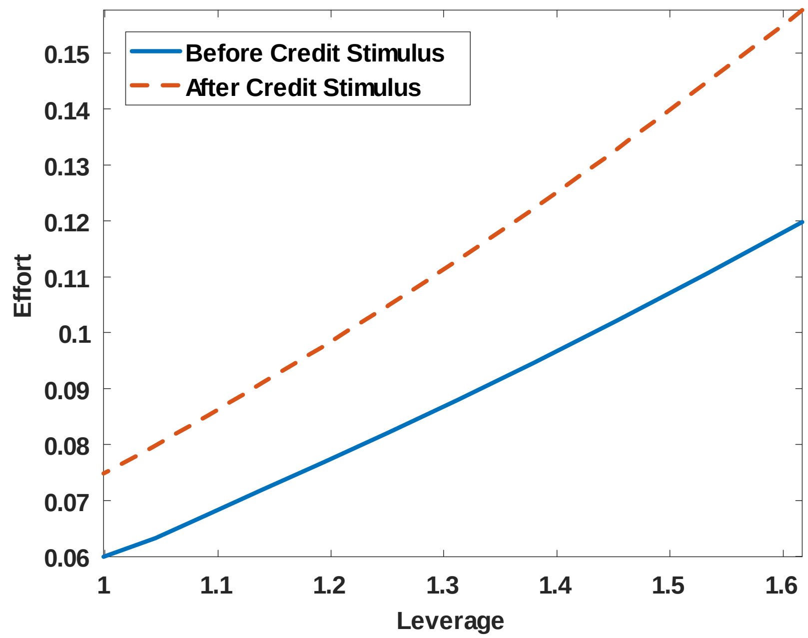


Figure 2.A5. CEO effort and leverage. This figure plots the relationship between firm leverage and CEO effort before and after a credit stimulus. The solid line represents the relationship between leverage and CEO effort before the credit stimulus when the borrowing cost for the firm is high. The dashed line represents the same relationship but after the credit stimulus when the borrowing cost for the firm is low.

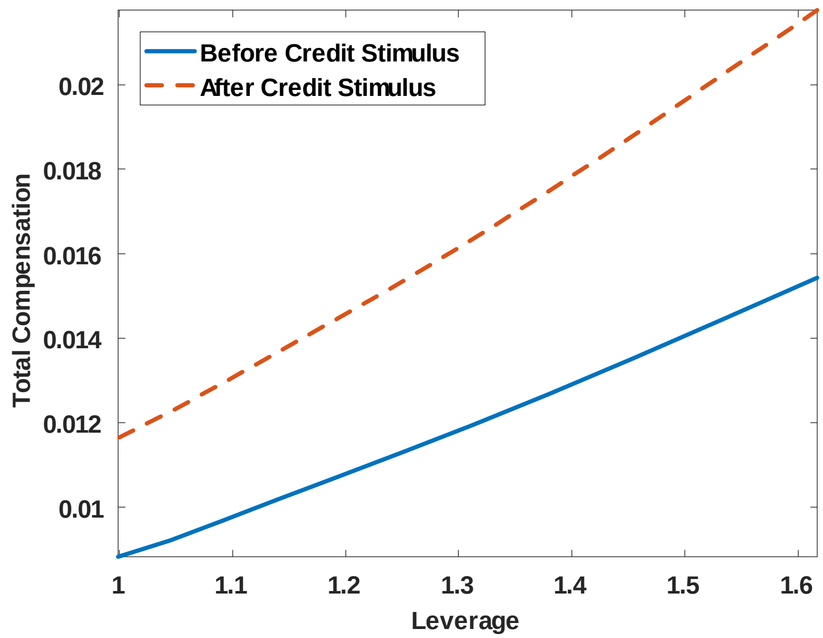


Figure 2.A6. Leverage and total CEO compensation. This figure plots the relationship between total CEO compensation and firm leverage before and after a credit stimulus. The solid line represents the relationship between leverage and total CEO compensation before the credit stimulus when the borrowing cost for the firm is high. The dashed line represents the same relationship but after the credit stimulus when the borrowing cost for the firm is low.

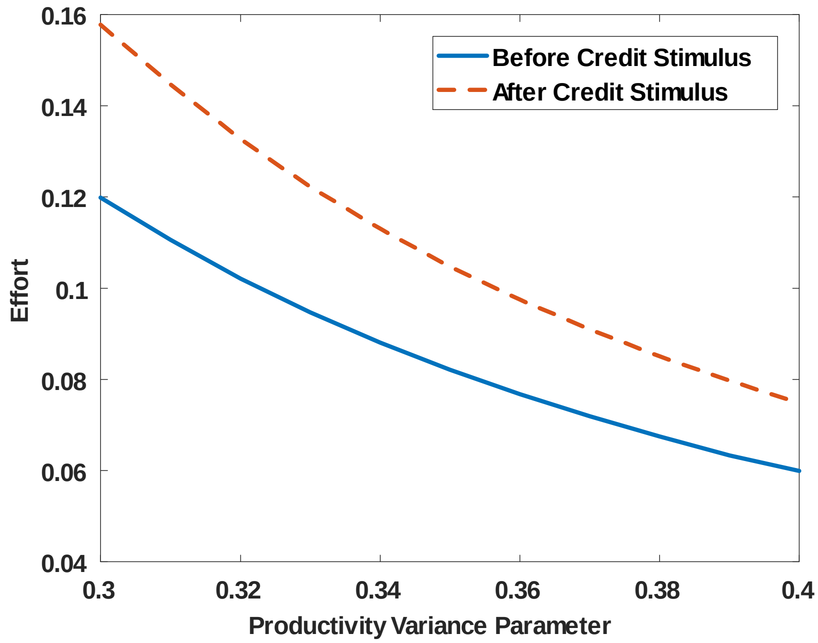


Figure 2.A7. CEO effort and productivity variance parameter (σ). This figure plots CEO effort for different productivity variance parameter (σ) values that represent different risk levels. The solid line represents the relationship between productivity variance parameter (σ) and CEO effort before the credit stimulus when the borrowing cost for the firm is high. The dashed line represents the same relationship but after the credit stimulus when the borrowing cost for the firm is low.

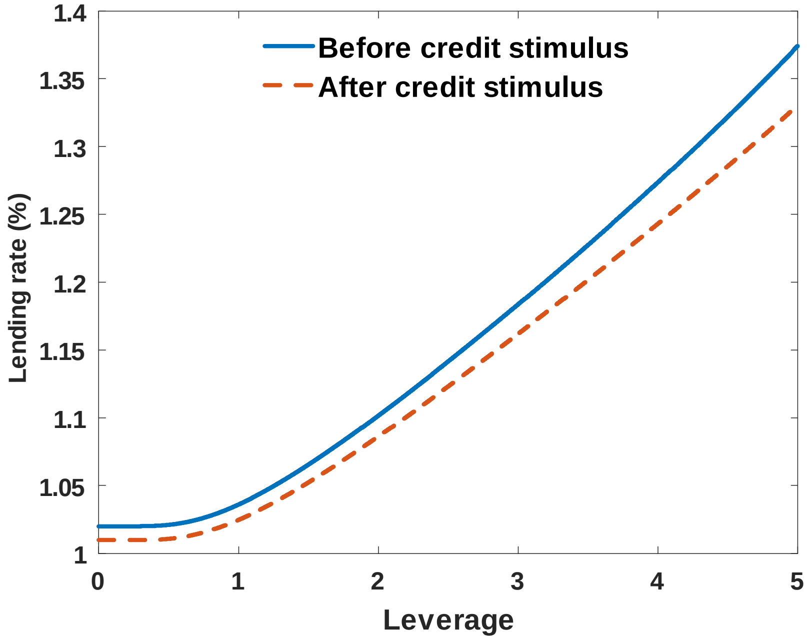


Figure 2.A8. Effects of a credit stimulus on credit supply and firm's leverage. This figure plots credit supply (Equation 2.6) before and after a credit stimulus to lenders' cost of funds. The solid line represents the relationship between lending rate and firm leverage before a credit stimulus. The dashed line represents the same relationship but after a credit stimulus.

Chapter 3

CLIMATE RISKS IN HOUSING MARKETS: EVIDENCE FROM NEWS SHOCKS[35]

3.1 Introduction

Sea level rise is a major physical risk associated with climate change. It is a long-run menace and there is wide debate on how and when housing markets will price it. For example, Bernstein et al. (2019) or Giglio et al. (2021) show that flood risk exposure or mentions of climate risks reduce property prices. On the other hand, Murfin and Spiegel (2020) fail to find any impact of flood risk on coastal property prices. While Keys and Mulder (2020) show a positive relationship between climate risk and housing prices for 2013-2018. In this paper we use two natural experiments to show that climate news shocks cause immediate and persistent drop in housing price and transaction number. Thus, climate risk awareness seems to be the key factor driving housing market reaction to climate threats. This is one of the earliest papers to study climate news in the spirit of those studied by the macro news literature as Barsky and Sims (2011) or Schmitt-Grohe and Uribe (2012). That is, impactful news about a future shock of sea level rise can drive housing prices and housing transaction numbers.

La Manga del Mar Menor (La Manga) is an artificially created spit of sandy, low-lying coastal land in Spain (see Figure A1 in the Appendix). It is a popular beach resort and has an active real estate market. Because of these reasons, to raise awareness about climate change in Spain, Greenpeace has focused its campaigns on La Manga. First, in 2007 Greenpeace published modified photos of a submerged La Manga with only the upper sections of the hotels and the apartment blocks emerging from the sea (see Figure A2 in the Appendix). This report generated alarm and La Manga's real estate companies sued Greenpeace claiming that the

[35] The materials in this chapter are based on joint research work with Clara Martinez-Toledano and Pedro Gete

report caused La Manga housing prices to plummet.[36]

Then, on Earth Day of 2014 Greenpeace published another impactful report stressing that La Manga will be completely inundated by the end of twenty first century as the melting of the polar ice caps rises the sea level. This new report again created widespread controversy and was widely discussed in the local press.[37] Both reports were completely unexpected.

We use a detailed Spanish housing transaction database for this study. This database contains daily transaction data at the zipcode level and covers the time periods around both 2007 and 2014 Greenpeace reports for transaction price and transaction number. We focus on both Greenpeace reports as exogenous climate news shocks to observe any change in average transaction price and transaction number. Furthermore, to get the extent of the impact of the Greenpeace reports on La Manga housing market, we use a set of Spanish locations on the Mediterranean coast as the benchmark control group. We use zipcodes to identify these coastal locations. We denote this control group as the "Mediterranean control group".

We find that average transaction price in La Manga drops immediately post publication of the 2007 and the 2014 Greenpeace reports. The drop in average transaction price is approximately 11% post 2007 shock and approximately 15% post 2014 shock relative to the benchmark control group. These findings suggest that housing stock prices react to news about localized climate risk even if it is a risk expected to occur at a distant future.

We do many things to confirm the robustness of our findings. First, we conduct difference-in-differences regressions comparing La Manga with a set of additional control groups. For this purpose, first we use a synthetic control group. We find that average transaction price in La Manga drops immediately post publication of the 2007 and the 2014 Greenpeace reports relative to this synthetic control group as well. The drop in average transaction price is approximately 10% post 2007 shock and approximately 16% post 2014 shock relative to this synthetic control group.

Second, we use a bigger control group consisting of all Spanish coastal zipcodes covering

[36] https://www.expatica.com/es/uncategorized/estate-owners-sue-greenpeace-for-prediction-38994/

[37] https://murciatoday.com/greenpeace-warn-la-manga-is-under-threat-from-global-warming_20899-a.html

the Mediterranean as well as the Atlantic coastlines. We denote this control group as the "total control group". We find that average transaction price in La Manga drops immediately post publication of the 2007 and the 2014 Greenpeace reports by approximately 19% and 4% respectively relative to this bigger control group as well.

We also use a smaller dataset around the 2014 Greenpeace shock containing monthly average data on listing price and housing rents.[38] First, we use this dataset to create a control group consisting of five neighboring coastal zipcodes to that of La Manga. We denote this control group as the "coastal control group". The second control group we create from this smaller dataset consists of locations in close proximity to La Manga that are not coastal locations. We denote this control group as the "neighboring control group". We use the "coastal control group" and the "neighboring control group" to compare listing prices. We also study two additional control groups (Torrevieja and South Torrevieja) used by Garcia-Lorenzo et al. (2021) and Banco de Espana (2021). Unlike La Manga, none of the locations in these four control groups were exposed to Greenpeace awareness campaigns highlighting the threat of sea level rise.

Second, we capture the impact of a real pollution shock, i.e., an algal bloom that hit La Manga in 2016, on the La Manga housing market. Garcia-Lorenzo et al. (2021) and Banco de Espana (2021) study this other shock. The algal bloom is an actual shock and not a virtual news shock as we are studying in this paper. As an actual shock affects the real estate market both in the short term and in the long term, literature suggests that both housing price and housing rents in La Manga will drop immediately. This is exactly what we find. The 2016 algal bloom caused a drop in both housing price (by approximately 14%) and housing rents (by approximately 3%) in La Manga.

Prior to both Greenpeace shocks, the treatment and the control groups satisfy the parallel trends assumption. They do not differ in key variables. Publication of both 2007 and 2014 Greenpeace reports were unexpected and exogenous. In addition, all our regressions control for

[38]We do not have data around the 2007 shock from this smaller dataset.

economic variables that affect housing markets. We also control for the global financial crisis that spanned from 2008 to 2014, the algal bloom in La Manga that affected the La Manga housing market during the 2016-2018 period. Finally, we control for the global sea level. These are alternative factors that can affect coastal housing markets.

No matter against which benchmark control group we compare with, transaction prices in La Manga fall in the range of 4% and 24% post publication of the Greenpeace reports. Thus, the core finding of the paper is very strong. We find that transaction price in La Manga around both Greenpeace shocks drop significantly relative to the control groups. However, transaction number in La Manga remains unchanged post 2007 Greenpeace report but drops by approximately 9% post publication of the 2014 Greenpeace report relative to the benchmark control group. We find similar results for listing price where the listing price in La Manga drops in the range of 5% to 10% relative to different control groups.

These findings suggest that both listing price and transaction price react negatively to news about localized climate risk even if it is a distant risk. On the contrary, housing transaction number trend suggests that buyers want to be convinced about the risk of distant climate change before deciding to opt out of purchasing homes. The 2014 Greenpeace report, which doubled down on their claim made in 2007 about inundation in La Manga convinced the buyers about the distant climate risk. Hence, the transaction numbers in La Manga dropped post 2014 Greenpeace report.

Furthermore, foreign nationals are willing to pay around 4% more post 2007 shock but around 2% more post 2014 shock than Spanish buyers in La Manga relative to the benchmark control group. In other words, Spanish home buyers incorporate climate risk better in transaction price in La Manga than other foreign buyers.

This paper contributes to the growing literature on the effects of sea level rise on housing prices. As discussed earlier, literature on this topic is divided. On one side, papers such as Baldauf et al. (2020), Bernstein et al. (2019), Giglio et al. (2021) or, Ortega and Taspinar (2018) show a negative effect. On the other hand, Murfin and Spiegel (2020) show no effect.

Keys and Mulder (2020), using data from coastal Florida real estate, show that for 2013-2018, home prices grew in the most SLR exposed communities, only in 2018-2020 prices declined by roughly 5% from their 2016 peak. Stroebel and Wurgler's (2021) survey of academics, policymakers and practitioners find that future climate risks are likely underestimated when pricing real estate.

Our study differs from previous literature on an important dimension. We focus on news shocks that alters beliefs about sea level rise (SLR). To our knowledge, other than Agarwal et al. (2021), no other paper has looked at information shocks that change climate beliefs. Previous literature have studied how current beliefs alter the effects of climate risks on housing prices. The literature measures such beliefs with different proxies. For example, Bernstein et al. (2019) and Ilhan (2021) use political beliefs as proxy, Baldauf et al. (2020) use the Yale survey on Climate Change, Bakkensen and Barrage (2021) conduct their own survey amongst coastal residents.

We are able to identify news shocks that directly change climate risk beliefs. These climate news shocks are equivalent to the productivity news shocks studied in macro since Beaudry and Portier (2006). Agarwal et al. (2021) also study a climate news shock, the impact on housing prices of a speech about climate risk by the prime minister of Singapore. Our results support the view that climate risk awareness is a necessary and sufficient condition for housing prices and housing stock to reflect climate risk concerns.

The paper is organized as follows: Section 3.3 studies transaction prices and housing rents in La Manga. Section 3.4 contains the diff-in-diff analysis. Section 3.5 investigates the impact of the Greenpeace reports on average transaction price in La Manga based on buyer nationality. Section 3.6 shows robustness tests. Section 3.7 concludes.

3.2 Introducción

El aumento del nivel del mar es un riesgo físico importante asociado con el cambio climático. Es una amenaza a largo plazo y existe un amplio debate sobre cómo y cuándo los mercados inmobiliarios le darán precio. Por ejemplo, Bernstein et al. (2019) o Giglio et al. (2021) muestran que la exposición al riesgo de inundaciones o las menciones de riesgos climáticos reducen los precios de las propiedades. Por otro lado, Murfin y Spiegel (2020) no encuentran ningún impacto del riesgo de inundaciones en los precios de las propiedades costeras. Mientras que Keys y Mulder (2020) muestran una relación positiva entre el riesgo climático y los precios de la vivienda para 2013-2018. En este artículo utilizamos dos experimentos naturales para mostrar que las noticias sobre el cambio climático causan una caída inmediata y persistente en el precio de la vivienda y el número de transacciones. Por lo tanto, la conciencia del riesgo climático parece ser el factor clave que impulsa la reacción del mercado inmobiliario a las amenazas climáticas. Este es uno de los primeros artículos en estudiar noticias climáticas en el espíritu de aquellos estudiados por la literatura de noticias macro como Barsky y Sims (2011) o Schmitt-Grohe y Uribe (2012). Es decir, las noticias impactantes sobre un impacto futuro del aumento del nivel del mar pueden impulsar los precios de la vivienda y las cifras de transacciones de vivienda.

La Manga del Mar Menor (La Manga) es una lengua de tierra costera baja y arenosa creada artificialmente en España (ver Figura 3.A1 en el Apéndice). Es un popular balneario y tiene un mercado inmobiliario activo. Por estos motivos, para concienciar sobre el cambio climático en España, Greenpeace ha centrado sus campañas en La Manga. Primero, en 2007 Greenpeace publicó fotos modificadas de La Manga sumergida con solo las secciones superiores de los hoteles y los bloques de apartamentos emergiendo del mar (ver Figura 3.A2 en el Apéndice). Este informe generó alarma y las empresas inmobiliarias de La Manga demandaron a Greenpeace alegando que el informe provocó la caída en picado de los precios de la vivienda en La Manga.[39]

Luego, en el Día de la Tierra de 2014, Greenpeace publicó otro informe impactante que destaca que La Manga estará completamente inundada a fines del siglo veintiuno a medida que el derretimiento de los casquetes polares aumente el nivel del mar. Este nuevo informe volvió a crear una amplia controversia y fue ampliamente discutido en la prensa local.[40] Ambos informes

[39] https://www.expatica.com/es/uncategorized/estate-owners-sue-greenpeace-for-prediction-38994/

[40] https://murciatoday.com/greenpeace-warn-la-manga-is-under-threat-from-global-warming_20899-a.html

fueron completamente inesperados.

Utilizamos una base de datos detallada de transacciones de vivienda en España para este estudio. Esta base de datos contiene datos de transacciones diarias a nivel de código postal y cubre los períodos de tiempo alrededor de los informes de Greenpeace de 2007 y 2014 para el precio de transacción y el número de transacción. Nos enfocamos tanto en los informes de Greenpeace como en las noticias exógenas sobre el clima para observar cualquier cambio en el precio promedio de transacción y el número de transacciones. Además, para conocer el alcance del impacto de los informes de Greenpeace en el mercado inmobiliario de La Manga, utilizamos un conjunto de ubicaciones españolas en la costa mediterránea como grupo de control de referencia. Usamos códigos postales para identificar estas ubicaciones costeras. Denotamos este grupo de control como el "grupo de control mediterráneo".

Encontramos que el precio promedio de transacción en La Manga cae inmediatamente después de la publicación de los informes de Greenpeace de 2007 y 2014. La caída en el precio de transacción promedio es de aproximadamente un 11% posterior al impacto de 2007 y aproximadamente un 15% posterior al impacto de 2014 en relación con el grupo de control de referencia. Estos hallazgos sugieren que los precios de las acciones inmobiliarias reaccionan a las noticias sobre el riesgo climático localizado, incluso si se espera que ocurra en un futuro lejano.

Hacemos muchas cosas para confirmar la solidez de nuestros hallazgos. Primero, llevamos a cabo regresiones de diferencias en diferencias comparando La Manga con un conjunto de grupos de control adicionales. Para este propósito, primero usamos un grupo de control sintético. Encontramos que el precio promedio de transacción en La Manga cae inmediatamente después de la publicación de los informes de Greenpeace de 2007 y 2014 en relación con este grupo de control sintético también. La caída en el precio de transacción promedio es de aproximadamente un 10% posterior al impacto de 2007 y aproximadamente un 16% posterior al impacto de 2014 en relación con este grupo de control sintético.

En segundo lugar, usamos un grupo de control más grande que consta de todos los códigos postales costeros españoles que cubren tanto el Mediterráneo como las costas atlánticas. Denotamos este grupo de control como el "grupo de control total". Encontramos que el precio promedio de transacción en La Manga cae inmediatamente después de la publicación de los informes de Greenpeace de 2007 y 2014 en aproximadamente un 19% y un 4% respectivamente en relación con este grupo de control más grande también.

También usamos un conjunto de datos más pequeño sobre el shock de Greenpeace de 2014 que contiene datos promedio mensuales sobre el precio de cotización y los alquileres de viviendas.[41] Primero, usamos este conjunto de datos para crear un grupo de control que consta de cinco códigos postales costeros vecinos al de La Manga. Denotamos este grupo de control como el "grupo de control costero". El segundo grupo de control que creamos a partir de este conjunto de datos más pequeño consta de ubicaciones muy próximas a La Manga que no son ubicaciones costeras. Denotamos este grupo de control como el "grupo de control vecino". Usamos el "grupo de control costero" y el "grupo de control vecino" para comparar los precios de cotización. También estudiamos dos grupos de control adicionales (Torrevieja y Sur de Torrevieja) utilizados por García-Lorenzo et al. (2021) y Banco de España (2021). A diferencia de La Manga, ninguno de los lugares de estos cuatro grupos de control estuvo expuesto a las campañas de concienciación de Greenpeace que destacaban la amenaza del aumento del nivel del mar.

En segundo lugar, capturamos el impacto de un choque de contaminación real, es decir, una proliferación de algas que afectó a La Manga en 2016, en el mercado inmobiliario de La Manga. García-Lorenzo et al. (2021) y Banco de España (2021) estudian este otro shock. La floración de algas es un shock real y no un shock de noticias virtual como estamos estudiando en este artículo. Dado que un shock real afecta al mercado inmobiliario tanto a corto como a largo plazo, la literatura sugiere que tanto el precio de la vivienda como el alquiler de la vivienda en La Manga caerán de inmediato. Esto es exactamente lo que encontramos. La proliferación de algas de 2016 provocó una caída tanto en el precio de la vivienda (en aproximadamente un

[41] No tenemos datos sobre el shock de 2007 de este conjunto de datos más pequeño.

14%) como en los alquileres de la vivienda (en aproximadamente un 3%) en La Manga.

Antes de los dos choques de Greenpeace, los grupos de tratamiento y de control satisfacen el supuesto de tendencias paralelas. No difieren en las variables clave. La publicación de los informes de Greenpeace de 2007 y 2014 fue inesperada y exógena. Además, todas nuestras regresiones controlan las variables económicas que afectan los mercados inmobiliarios. También controlamos la crisis financiera mundial que se extendió de 2008 a 2014, la proliferación de algas en La Manga que afectó al mercado inmobiliario de La Manga durante el período 2016-2018. Finalmente, controlamos por el nivel global del mar. Estos son factores alternativos que pueden afectar los mercados inmobiliarios costeros.

Independientemente del grupo de control de referencia con el que comparemos, los precios de transacción en La Manga caen en el rango de 4% y 24% después de la publicación de los informes de Greenpeace. Por lo tanto, el hallazgo central del documento es muy fuerte. Encontramos que el precio de transacción en La Manga alrededor de ambos choques de Greenpeace cae significativamente en relación con los grupos de control. Sin embargo, el número de transacciones en La Manga permanece sin cambios después del informe de Greenpeace de 2007, pero cae aproximadamente un 9% después de la publicación del informe de Greenpeace de 2014 en relación con el grupo de control de referencia. Encontramos resultados similares para el precio de cotización donde el precio de cotización en La Manga cae en el rango de 5% a 10% en relación con diferentes grupos de control.

Estos hallazgos sugieren que tanto el precio de cotización como el precio de transacción reaccionan negativamente a las noticias sobre el riesgo climático localizado, incluso si se trata de un riesgo lejano. Por el contrario, la tendencia del número de transacciones de vivienda sugiere que los compradores quieren estar convencidos sobre el riesgo de un cambio climático lejano antes de decidir no comprar viviendas. El informe de Greenpeace de 2014, que duplicó su afirmación realizada en 2007 sobre las inundaciones en La Manga, convenció a los compradores sobre el riesgo climático lejano. Por lo tanto, los números de transacciones en La Manga cayeron después del informe de Greenpeace de 2014.

Además, los ciudadanos extranjeros están dispuestos a pagar alrededor de un 4% más después del shock de 2007 pero alrededor de un 2% más después del shock de 2014 que los compradores españoles en La Manga en relación con el grupo de control de referencia. En otras palabras, los compradores de vivienda españoles incorporan mejor el riesgo climático en el precio de transacción en La Manga que otros compradores extranjeros.

Este documento contribuye a la creciente literatura sobre los efectos del aumento del nivel del mar en los precios de la vivienda. Como se discutió anteriormente, la literatura sobre este tema está dividida. Por un lado, trabajos como el de Baldauf et al. (2020), Bernstein et al. (2019), Giglio et al. (2021) o, Ortega y Taspinar (2018) muestran un efecto negativo. Por otro lado, Murfin y Spiegel (2020) no muestran ningún efecto. Keys y Mulder (2020), utilizando datos de bienes raíces en la costa de Florida, muestran que para 2013-2018, los precios de las viviendas aumentaron en las comunidades más expuestas a SLR, solo en 2018-2020 los precios disminuyeron aproximadamente un 5% desde su pico de 2016. La encuesta de Stroebel y Wurgler (2021) a académicos, formuladores de políticas y profesionales revela que es probable que se subestimen los riesgos climáticos futuros al fijar el precio de los bienes inmuebles.

Nuestro estudio difiere de la literatura previa en una dimensión importante. Nos enfocamos en noticias impactantes que alteran las creencias sobre el aumento del nivel del mar (SLR). Hasta donde sabemos, aparte de Agarwal et al. (2021), ningún otro artículo ha analizado los choques de información que cambian las creencias climáticas. La literatura previa ha estudiado cómo las creencias actuales alteran los efectos de los riesgos climáticos en los precios de la vivienda. La literatura mide tales creencias con diferentes proxies. Por ejemplo, Bernstein et al. (2019) e Ilhan (2021) utilizan las creencias políticas como proxy, Baldauf et al. (2020) utilizan la encuesta de Yale sobre el cambio climático, Bakkensen y Barrage (2021) realizan su propia encuesta entre los residentes costeros.

Somos capaces de identificar impactos noticiosos que cambian directamente las creencias sobre el riesgo climático. Estos shocks de noticias climáticas son equivalentes a los shocks de noticias de productividad estudiados en macro desde Beaudry y Portier (2006). Agarwal et al.

(2021) también estudian una noticia sobre el clima, el impacto en los precios de la vivienda de un discurso sobre el riesgo climático del primer ministro de Singapur. Nuestros resultados respaldan la opinión de que la conciencia del riesgo climático es una condición necesaria y suficiente para que los precios de la vivienda y el stock de viviendas reflejen las preocupaciones sobre el riesgo climático.

El artículo está organizado de la siguiente manera: La Sección 3.3 estudia los precios de transacción y los alquileres de viviendas en La Manga. La Sección 3.4 contiene el análisis diff-in-diff. La Sección 3.5 investiga el impacto de los informes de Greenpeace en el precio medio de transacción en La Manga en función de la nacionalidad del comprador. La Sección 3.6 muestra las pruebas de robustez. La Sección 3.7 concluye.

3.3 Transaction Prices and Housing Rents in La Manga

We analyze monthly data on transaction price from Spanish registry around both 2007 and 2014 Greenpeace shocks. We focus on the period from 2004 to 2013 for the 2007 Greenpeace shock (the shock occurred in November, 2007). For the 2014 Greenpeace shock (the shock occurred in April, 2014) we focus on the period from 2009 to 2021. We control for the period when the algal bloom hit La Manga (i.e., 2016 to 2018) as documented by Carvalho-Machando Saez (2020), Garcia-Lorenzo et al. (2021) and Banco de Espana (2021). We also analyze monthly listing price and rental data from Idealista, the leading real estate platform in Spain, around the 2014 Greenpeace shock.

Figure 3.1 plots listing price and housing rents in La Manga around the 2014 Greenpeace report. Two facts are striking: the report causes a significant drop in listing price, but it has no effect on housing rents. Figure 3.2 shows the consequent collapse in the listing price-to-rent ratio.

To rigorously check if housing prices (both transaction and listing prices) and housing rents are affected by the Greenpeace reports we test for structural breaks. In Figures 3.3 to 3.6 we test for structural breaks like McConnell and Perez-Quiros (2000) or, Smith (2008). We do the cumulative sum test for parameter stability (CUSUM). This test uses the cumulative sum of OLS residuals to determine whether there is a structural break. Under the null hypothesis that the coefficients are stable over time, the cumulative sum of residuals will have mean zero. If the cumulative sum of the residuals goes outside the confidence interval then there is parameter instability.

Figures 3.3 and 3.4 plot the CUSUM test for average transaction price in La Manga around the 2007 and the 2014 Greenpeace shocks respectively. Figures 3.5 and 3.6 report the CUSUM test for listing price and for housing rents in La Manga around the 2014 Greenpeace shock respectively. Figures 3.3, 3.4 and 3.5 show structural breaks in housing prices in La Manga around the publication of the 2007 and 2014 Greenpeace reports.[42] However, Figure 3.6 suggests no structural break for housing rents around the 2014 shock. The shaded areas in Figure 3.3 to Figure 3.6 indicate 95% confidence interval.

Tables 3.1 and 3.2 report monthly results from the Wald test which tests the null hypothesis of no structural break. This test is robust to the presence of unknown heteroskedasticity. Table 3.1 shows structural break for average transaction price around the 2007 Greenpeace shock. Table 3.2 shows structural break for both average transaction price (Column 1) and listing price (Column 2) while no structural break for housing rents is observed (Column 3) around the 2014 Greenpeace shock. Thus, Tables 3.1 and 3.2 together with Figures 3.3, 3.4 and 3.5 strongly suggest that the Greenpeace reports caused structural breaks in housing prices. However, Table 3.2 and Figure 3.6 show that the 2014 Greenpeace report had no effect on housing rents.

These findings are consistent with an asset pricing view of housing prices as risk adjusted present discounted value of future rents. Sea level rise is a distant shock that will affect future rents when it materializes, but such a distant threat of sea level rise is not preventing people from enjoying the beach amenities in La Manga at present. Thus, rents are not affected.

It is important to stress that both the 2007 and the 2014 Greenpeace reports are news shocks, that is, they are news about a shock occurring in a distant future. Shocks of distant

[42] We could not test for structural break for listing prices and housing rents around the 2007 Greenpeace shock due to data unavailability.

climate risk affect the housing market in the long term but not in the short term. Our findings confirm this theory. The price of the asset reacts (housing prices) but the price of the current service flow (housing rents) is unaffected by the news shock.

To further confirm that we are identifying a news shock, Figures 3.7 and 3.8 study the algal bloom that hit La Manga since 2016. An algal bloom is a current shock that should impact both the ownership and the rental markets. This is exactly what we find. Figure 3.7 shows that the 2016 algal bloom causes a significant drop in listing price (by 12.63%) and housing rents (by 2.70%). The listing price to rent ratio increases because the algal bloom is a present but transitory shock (see Figure 3.8).

Comparing Figures 3.1 and 3.2 with Figures 3.7 and 3.8 we show different natures of a climate news shock versus an actual pollution shock (i.e., the algal bloom) on real estate market. The news shock only moves prices and it causes a fall in the price-to-rent ratio. On the other hand, the algal bloom increases this ratio and affects both prices and rents. The implications for these two different types of shocks for search-for-yield investors are very different. News shocks attract search-for-yield investors who are short-term oriented. On the contrary, a pollution shock is unlikely to attract any search-for-yield investors in the immediate future.

3.4 Diff-in-Diff Analysis

We follow a difference-in-differences methodology in this paper. First we discuss the control groups, then we present the analysis and the results. Our identification assumption is that the differences in the dynamics of the treatment and control groups post 2007 and post 2014 Greenpeace report periods are caused exclusively by the Greenpeace reports.

3.4.1 Treatment and Control Groups

Our treatment group is La Manga which belongs to San Javier municipality. We have transaction price data at the zipcode level from all areas of La Manga. Listing price, housing rents and sea level rise data are at the municipality level. The economic controls are at the province level.

Benchmark Control Group Our benchmark control group consists of three hundred and twenty six zipcodes located on the Mediterranean coastline. This control group is denoted as "Mediterranean control group". This benchmark control group consists of coastal zipcodes from Cataluna (ninety three zipcode locations), Comunidad de Valenciana (eighty zipcode locations), Murcia (sixteen zipcode locations) and Andalusia (one hundred and thirty seven zipcode locations).

Control groups for robustness purposes Apart from the benchmark control group, we use two large control groups (i.e., synthetic and total) and four smaller control groups (i.e., coastal, neighboring, Torrevieja and South Torrevieja) for robustness tests.

The first of the larger control groups is denoted as the "synthetic control group". This control group is created based on two hundred and seventy seven Mediterranean coastal zipcodes. We provide a detailed discussion about the same in Section 3.4.

The second of the large control group consists of seven hundred and thirty five zipcodes across both Mediterranean and the Atlantic coastlines. We provide a detailed discussion about the same in Section 3.4.

The first of the smaller control groups used for robustness testing purpose is denoted as "coastal control group". This control group consists of similar Mediterranean coastal locations in close proximity to La Manga. These locations include: Alicante, Malaga, Marbella, Nerja and Torrevieja.

We also use a "neighboring control group" to compare the housing market with La Manga. This control group includes neighboring locations to La Manga but are located offshore. The locations in this control group are Guardamar del Segura, and Pilar de la Horadada.

We use these two control groups to compare with La Manga housing market for both climate news shock (i.e., the 2014 Greenpeace shock) and actual environmental shock (i.e., the 2016 algal bloom in La Manga).

Tables 3.3 and 3.4 compare the control groups with La Manga across a set of socioeconomic variables. The goal is to ensure that the control groups have similar characteristics to those of La Manga before the publication of the Greenpeace reports. We use monthly data at the municipality level for transaction prices. We also use monthly data at the province level to control for changes in population, inflation and unemployment.

Tables 3.3 and 3.4 show that the control groups and La Manga are quite similar during the pre shock periods for the variables of interest. All tests of equality of pre shock means reject any significant differences across La Manga and the control groups. Only exceptions are unemployment rate change and population change pre 2014 shock. This is not much of a worry as we control for both in all of our specifications.

3.4.2 Housing Prices

We use two sample periods surrounding the two Greenpeace shocks to compare transaction prices. First sample period consists of 2004-2013 while the second sample period consists of 2009-2021. We have data on transaction prices for both sample periods. Figure 3.9 to Figure 3.12 check the parallel trends assumption for housing prices. Figure 3.9 compares La Manga and the Mediterranean control group around the 2007 Greenpeace shock. Figure 3.10 replicates Figure 3.9 but around the 2014 Greenpeace shock.

Parallel trends assumption holds perfectly in all cases. The dynamics of housing prices in La Manga and in the control groups are very similar before both Greenpeace reports. Post publication of the Greenpeace report, the average transaction price in La Manga experiences a significant drop relative to those in the benchmark control group (see Figures 3.9, 3.10). We also provide additional proof of the same by plotting the regression parameter for La Manga over time for both shocks (see Figures 3.11 and 3.12). These findings suggest that locations which are not under continuous exposure to climate risk news benefit from a higher demand due to their relative safety from the threat of sea level rise.

To quantify the effect of the Greenpeace reports we estimate the following specification:

$$Log(Housingprice_{i,t}) = \beta_0 + \beta_1 LaManga + \beta_2 Postreport + \beta_3 LaManga \times Postreport + \\ + \sum_k \beta_k Controls_{i,t,k} \quad 3.1$$

where, $Log(Housingprice_{i,t})$ refers to the percentage change in housing price at location i in time t. The locations are La Manga and the control groups. $LaManga$ is a dummy that takes the value of one for La Manga and zero for the locations in the control groups. $Postreport$ is a dummy that takes the value of one for the post shock periods, and zero otherwise. The interaction term $LaManga \times Postreport$ captures the effect of the report in La Manga during the post shock periods. Thus, β_3 is the coefficient of interest for us. $Controls_{i,t,k}$ are the k control variables at location i in time t. We control for inflation, population, and unemployment.[43] Furthermore, we control for an increase in the sea level as a higher sea level could affect the housing markets by creating stranded assets.[44] We also control for the global financial crisis that lasted in Spain from 2008 to 2014. For the sample period around the 2007 Greenpeace shock (i.e., 2004-2013), we include a dummy from January 2008 to December 2009 to control for the financial shock. On the other hand, for the sample period around the 2014 Greenpeace shock (i.e., 2009-2021), we include a dummy from January 2009 to December 2014 to control for the global financial shock. Finally, we include a dummy from January 2016 to December 2018 to control for the impact of the algal bloom that occurred in La Manga around this period.

Table 3.5 has summary statistics for all variables in the sample. Table 3.6 contains the results of average transaction price around the 2007 and the 2014 shocks from estimating Equation 3.1. Column 1 of Table 3.6 shows that in the post 2007 period, average transaction price is 11% lower in La Manga relative to the benchmark Mediterranean control group. On the other hand, Column 2 of Table 3.6 shows that in the post 2014 shock period, average transaction price is 15% lower in La Manga than in the benchmark Mediterranean control group.

[43] These controls come from the Spanish National Statistical Institute database. For inflation and unemployment, the controls are at the province level.

[44] The sea level measure comes from Sealevels.org, which maintains a longitudinal data of global sea level rise.

Thus, news shocks about sea level rise have immediate effects on transaction price.

3.5 Transaction Price by Buyer Nationality

In this section we explore if the 2007 and the 2014 Greenpeace shocks have bigger adverse effects on Spanish home buyers and buyers relative to foreign buyers in La Manga. Figure 3.13 compares average transaction price in La Manga between Spanish and foreign buyers around the 2007 Greenpeace shock. Figure 3.14 replicates Figure 3.13 but around the 2014 Greenpeace shock. Both shocks cause additional drops in average transaction price paid by Spanish home buyers relative to those paid by the foreign buyers. To formally quantify, we estimate:

$$Log(Averagetransactionprice_t) = \beta_0 + \beta_1 Spanish + \beta_2 Postreport + \beta_3 Spanish \times Postreport + \sum_k \beta_k Controls_{i,t,k} \qquad 3.2$$

where, $Log(Averagetransactionprice_{i,t})$ represents the percentage change in average transaction price in La Manga in time t. *Spanish* represents a dummy that takes the value of one if the buyer is a Spanish national and zero otherwise. $Spanish \times Postreport$ represents the interaction term that takes the value of one for Spanish buyers post Greenpeace shocks and zero otherwise. Hence, β_3 is our coefficient of interest.

Table 3.7 compares the impact of the Greenpeace reports on average transaction price in La Manga between Spanish and foreign buyers. Column 1 of Table 3.7 shows an additional 4% drop in average transaction price paid by the Spanish buyers relative to those paid by the foreign buyers post 2007 Greenpeace shock. However, Column 2 of Table 3.7 shows an additional 2% drop in average transaction price paid by Spanish buyers relative to those paid by foreign buyers post 2014 Greenpeace shock.

These findings suggest that in locations facing inundation in distant future, the housing market remains active, however Spanish buyers are not willing to pay as high as the foreign buyers. That is, knowledgeable local buyers are willing to be exposed to the future threat of sea level rise in La Manga, but at lower prices in order to reduce their climate risk exposure.

3.6 Robustness Tests

We perform several robustness tests to validate our results. First we use a set of additional control groups to test for the robustness of our findings. Second, we capture how transaction number reacts to the impact of the Greenpeace reports relative to the benchmark control group (i.e., the Mediterranean control group). Finally, we use placebo tests using November 2006 as placebo shock for the 2007 Greenpeace report and April 2012 as placebo shock for the 2014 Greenpeace report.

3.6.1 Additional Control Groups

We use a set of control groups for robustness purpose. We use two large control groups (i.e., synthetic control group and total control group) for transaction price and transaction numbers. We also use four smaller control groups (i.e., coastal, neighboring, Torrevieja and South Torrevieja) to compare listing price and housing rents relative to those in La Manga.

Synthetic Control Group for Transaction Price Our first control group is a synthetic control group used to compare the average transaction price between La Manga and other similar Mediterranean coastal locations. Synthetic control group (SCG) approach is a new estimation approach implemented for natural experiments (Abadie and Gardeazabal, 2003; Abadie et al., 2010). Under this approach, a weighted combination of zip codes from a "donor control group" is used to create the synthetic control group. The relevant weights for the members of the synthetic control group are created based on a $(J \times 1)$ vector of weights $(W = w_2, ..., w_{J+1})'$. Where, $w_j \geq 0$ represents respective weights for $j (= 2, ..., J+1)$ members of the donor control group and $w_2 + ... + w_{J+1} = 1$. j represents the members of the donor control group. Each potential value of W represents a weighted average of zip codes. Each of these values of W is then used as weights to create a set of potential synthetic control groups. Mathematically the outcome variable for a synthetic control group is given as:

$$\sum_{j=2}^{J+1} w_j Y_{j,t}$$

Now, the basic diff-in-diff model specification is written as:

$$Y_{i,t} = Y_{i,t}^{N} + \alpha_{i,t} D_{i,t}$$

where, $Y_{i,t}$ and $Y_{i,t}^{N}$ represent the outcome variable in the treatment group and in the control group respectively. $D_{i,t}$ takes the value of one if the i-th zip code belonging to the treatment group (here, La Manga) at time t when the treatments (i.e., the Greenpeace shocks) are introduced and zero otherwise. Hence, $\alpha_{i,t}$ represents the treatment effect, i.e.,

$$\alpha_{i,t} = Y_{i,t} - Y_{i,t}^{N}.$$

Hence, the synthetic control group is created such that:

$$Y_{i,t}^{N} \approx \sum_{j=2}^{J+1} w_j^{*} Y_{j,t}$$

where, w_j^{*} closely approximates the weights of the outcome variable (here, transaction price) for the members of a real control group (i.e., $Y_{i,t}^{N}$).

The donor control group used here consists of three hundred and twenty six coastal zipcode locations on the Mediterranean coast. These three hundred and twenty six coastal zipcodes come from Andalusia (one hundred and thirty seven zipcode locations), Cataluna (ninety three zipcode locations), Comunidad de Valenciana (eighty zipcode locations) and Murcia (sixteen zipcode locations). The synthetic control group used in this study is similar on the most relevant characteristics of the treatment group (here, La Manga). Thus, the synthetic control group can be used as the counterfactual to that of La Manga.

Figure 3.15 compares La Manga and the synthetic control group around the 2007 Greenpeace shock. Figure 3.16 replicates Figure 3.15 but around the 2014 Greenpeace shock. Parallel trends assumption holds perfectly in all cases. The dynamics of transaction price in La Manga and in the synthetic control group is very similar before both Greenpeace reports. Post publication of the Greenpeace report, the average transaction price in La Manga experiences a significant drop relative to the synthetic control group (see Figures 3.15, 3.16).

Table 3.8 compares the impact of the Greenpeace reports on average transaction price between La Manga and the synthetic control group. Column 1 of Table 3.8 shows a 10% drop in average transaction price in La Manga relative to the synthetic control group post 2007 Greenpeace shock. On the other hand, Column 2 of Table 3.8 shows a 16% drop in average transaction price in La Manga relative to the synthetic control group post 2014 Greenpeace shock.

These findings provide support to our original findings.

Total Control Group for Transaction Price The total control group consists of seven hundred and thirty five coastal zipcode locations on the both Atlantic and Mediterranean coasts. These seven hundred and thirty five coastal zipcodes come from Andalusia (one hundred and thirty seven zipcode locations), Cataluna (ninety three zipcode locations), Comunidad de Valenciana (eighty zipcode locations), Murcia (sixteen zipcode locations), Galicia (two hundred and fifty zipcode locations), Asturias (seventy four zipcode locations), Cantabria (forty three zipcode locations) and Pais Basque (forty two zipcode locations). The control group used in this study is similar on the most relevant characteristics of the treatment group (here, La Manga). Thus, the total control group can be used as the counterfactual to that of La Manga.

Figure 3.17 compares La Manga and the total control group around the 2007 Greenpeace shock. Figure 3.18 replicates Figure 3.17 but around the 2014 Greenpeace shock. Parallel trends assumption holds perfectly in all cases. The dynamics of transaction price in La Manga and in the total control group is very similar before both Greenpeace reports. Post publication of the Greenpeace report, the average transaction price in La Manga experiences a significant drop relative to the total control group (see Figures 3.17, 3.18).

Table 3.9 compares the impact of the Greenpeace reports on average transaction price between La Manga and the total control group. Column 1 of Table 3.9 shows a 19% drop in average transaction price in La Manga relative to the total control group post 2007 Greenpeace shock. On the other hand, Column 2 of Table 3.9 shows a 4% drop in average transaction price in La Manga relative to the total control group post 2014 Greenpeace shock.

These findings again provide support to our original findings.

Smaller Control Groups We use four smaller control groups, namely, coastal, neighboring, Torrevieja and South Torrevieja to compare listing price and housing rents with La Manga.

First, we compare the listing price in La Manga to those of the coastal and neighboring control groups respectively around the 2014 Greenpeace shock. Figure 3.19 compares listing price between La Manga and the coastal control group around the 2014 Greenpeace shock, while Figure 3.20 replicates Figure 3.19 but for the neighboring control group. Table 3.10 contains the results of listing price around the 2014 shock from estimating Equation 3.1. The sample period used here is January 2013 to December 2015. Results show that post 2014 period, listing price is 7% lower in La Manga relative to the coastal control group (see Column 1 of Table 3.10). For the same time interval, listing price in La Manga is 5% lower than in the neighboring control group (see Column 2 of Table 3.10).

Next, we compare housing rents in La Manga to those of the coastal and neighboring control groups respectively around the 2014 Greenpeace shock. Figure 3.21 compares housing rents between La Manga and the coastal control group around the 2014 Greenpeace shock, while Figure 3.22 replicates Figure 3.21 but for the neighboring control group.

Table 3.11 contains the results of housing rents around the 2014 shock from estimating Equation 3.1. The sample period used here is January 2013 to December 2015. Results show that post 2014 period, housing rents do not vary significantly relative to the coastal control group (see Column 1 of Table 3.11). For the same time interval, housing rents in La Manga is 8% higher than rents in the neighboring control group (see Column 2 of Table 3.11).

We next check if our results change when we use control groups used by Garcia-Lorenzo et al. (2021) and Banco de Espana (2021) to study the 2016 algal bloom. They first use a municipality named Torrevieja. Second, they use a subsample of this municipality called South Torrevieja that includes Playa de Los Locos, Playa del Cura, Los Naufragos and Los Balcones.

Figures 3.23 to 3.26 plot average transaction price in La Manga and in these additional control groups around the two Greenpeace shocks. Tables 3.12 and 3.13 estimate the benchmark specification given in Equation 3.1 for average transaction price in La Manga and these control groups around the 2007 shock and the 2014 shocks respectively. The results are in line with the benchmark results discussed before. The 2007 Greenpeace report causes average transaction price to drop in La Manga by approximately 15% relative to Torrevieja (see Column 1 of Table 3.12) and by approximately by 24% relative to South Torrevieja (see Column 2 of Table 3.12). The 2014 Greenpeace report causes average transaction price to drop in La Manga by approximately 6% relative to Torrevieja (see Column 1 of Table 3.13) and by approximately 7% relative to South Torrevieja (see Column 2 of Table 3.13).

We observe a similar trend for listing price (see Figures 3.27 and 3.28). Listing price in La Manga drops by 9% relative to Torrevieja (see Column 1 of Table 3.14) and by 10% relative to South Torrevieja post 2014 Greenpeace report (see Column 2 of Table 3.14).

Thus, our original findings are robust to these alternative control groups.

3.6.2 Transaction Number

We next check how transaction number in La Manga change post Greenpeace shocks relative to our benchmark control group. Figures 3.29 and 3.30 plot transaction number in La Manga relative to the benchmark control group post 2007 and 2014 Greenpeace shocks respectively.

To quantify the effect of the Greenpeace reports we estimate the benchmark specification given in Equation 3.1 using log of transaction numbers as the dependent variable. Table 3.15 estimates the benchmark specification given in Equation 3.1 but average transaction number in La Manga and the benchmark control group as the dependent variable around the 2007 and the 2014 shocks respectively. The results are in line with the benchmark results discussed before. While the 2007 Greenpeace report does not cause any change in transaction number in La Manga relative to the benchmark control group post 2007 Greenpeace report (see Column 1 of Table 3.15), the 2014 Greenpeace report causes a drop in transaction number in La Manga by approximately 9% relative to benchmark control group (see Column 2 of Table 3.15).

These findings suggest that buyers will keep purchasing properties unless they are convinced about the threat of distant climate risk through reinforcement of such a threat.

3.6.3 Placebo Test

We perform a set of placebo tests to check the robustness of our results. We assume two random dates, namely, November 2006 as a placebo for the November 2007 Greenpeace shock and April 2012 as a placebo for the April 2014 Greenpeace shock. Then we redo the benchmark estimation as in Equation 3.1 using these two random dates as placebo shocks. Since no Greenpeace reports got published on either of these two random days, we should find no effect on housing prices in La Manga relative to the control groups.

Figure 3.31 plots the 2006 placebo shock and the actual 2007 Greenpeace shock for average transaction price in La Manga and the Mediterranean control group. Figure 3.32 recreates Figure 3.31 but for the 2014 shock. On the other hand, Figure 3.33 plots the 2012 placebo shock and the actual 2014 Greenpeace shock for listing price in La Manga and the coastal control group. Figure 3.34 recreates Figure 3.33 but for the neighboring control group.

Table 3.16 shows the results from estimating Equation 3.1 with the 2006 and the 2012 placebo shocks. Average transaction price in La Manga does not vary significantly post 2006 placebo shock (see Column 1 of Table 3.16) but increases by 3% post 2012 shock (see Column 2 of Table 3.16) relative to the Mediterranean control group .

Table 3.17 shows the results from estimating Equation 3.1 with the 2012 placebo shock for listing price. Listing price in La Manga does not change significantly relative to the coastal control group (see Column 1 of Table 3.17) but increases by 11% relative to the neighboring control group post 2012 placebo shock (see Column 2 of Table 3.17).

These findings are contrary to our original result relative to the actual Greenpeace shocks. Thus, we can conclude that we are not confounding the Greenpeace shock with other types of shocks.

3.7 Conclusions

There is disagreement in the literature about how much and when sea level rise will affect home prices. In this paper we show that prices react to impactful news. We exploit two

Greenpeace reports that received wide attention in a Spanish coastal region (La Manga) that is vulnerable to sea level rise.

We have high confidence that we are identifying both 2007 and 2014 Greenpeace shocks. Consistent with theory, we show that average transaction prices in La Manga react negatively to the reports with respect to the benchmark Mediterranean and the coastal control groups. We observe similar trends for listing price.

We also do a diff-in-diff analysis to quantify the effects from the reports. Parallel trends assumption holds well for both transaction prices and listing prices. We also control for other possible drivers of our findings. Again, we find significant drops in housing prices relative to all control groups. Housing prices in La Manga fell by around 5% to 15% across all control groups post Greenpeace shocks**.** However, No changes are observed in the rental markets. This suggests that markets are pricing the future reallocation of population. Furthermore, While the price effects are strong and statistically significant, these effects are even stronger for Spanish home buyers.

We also find that buyers keep on buying properties but at lower prices unless their threat of climate risk is reinforced. When such reinforcement occurs, transaction number also drop by 9%.

These findings suggest that buyers are willing to take risk of climate change by purchasing properties in La Manga but at a lower price level. Thus, we can conclude that, at least while sea level rise is more of a menace than a real danger, most of the effects will be felt in prices. Additionally, local home buyers, who are aware of such threats, will incorporate this climate threat while deciding their transaction prices. A topic for future research is how construction, new buildings and the mortgage lending sector react to such news shocks.

3.8 Conclusiones

Hay desacuerdo en la literatura acerca de cuánto y cuándo el aumento del nivel del mar afectará los precios de las viviendas. En este artículo mostramos que los precios reaccionan a noticias impactantes. Aprovechamos dos informes de Greenpeace que recibieron gran atención en una región costera española (La Manga) que es vulnerable al aumento del nivel del mar.

Confiamos mucho en que estamos identificando los impactos de Greenpeace de 2007 y 2014. De acuerdo con la teoría, mostramos que los precios promedio de transacción en La Manga reaccionan negativamente a los informes con respecto al Mediterráneo de referencia y los grupos de control costero. Observamos tendencias similares para el precio de cotización.

También hacemos un análisis de diferencia en diferencia para cuantificar los efectos de los informes. El supuesto de tendencias paralelas es válido tanto para los precios de transacción como para los precios de cotización. También controlamos otros posibles impulsores de nuestros hallazgos. Nuevamente, encontramos caídas significativas en los precios de la vivienda en relación con todos los grupos de control. Los precios de la vivienda en La Manga cayeron entre un 5% y un 15% en todos los grupos de control después de las crisis de Greenpeace. Sin embargo, no se observan cambios en los mercados de alquiler. Esto sugiere que los mercados están valorando la futura reasignación de población. Además, si bien los efectos de los precios son fuertes y estadísticamente significativos, estos efectos son aún más fuertes para los compradores de viviendas españoles.

También encontramos que los compradores continúan comprando propiedades pero a precios más bajos a menos que se refuerce su amenaza de riesgo climático. Cuando se produce dicho refuerzo, el número de transacciones también cae un 9%.

Estos hallazgos sugieren que los compradores están dispuestos a correr el riesgo del cambio climático comprando propiedades en La Manga pero a un nivel de precio más bajo. Por lo tanto, podemos concluir que, al menos mientras el aumento del nivel del mar es más una amenaza que un peligro real, la mayoría de los efectos se sentirán en los precios. Además, los compradores de viviendas locales, que son conscientes de tales amenazas, incorporarán esta amenaza climática al decidir sus precios de transacción. Un tema para futuras investigaciones es cómo la construcción, los nuevos edificios y el sector de préstamos hipotecarios reaccionan ante tales noticias.

3.9 Figures

Figure 3.1. Listing Price and Housing Rents in La Manga Around 2014 Shock. The solid line plots monthly listing price while the dashed line plots monthly housing rents. The vertical line (April 2014) is the month of publication of the 2014 Greenpeace report. The sample period is from January 2013 to December 2015.

Figure 3.2. Price-to-Rent Ratio in La Manga Around 2014 Shock. This figure plots the ratio of listing price to housing rents (monthly). The vertical line and the sample period are as described in Figure 3.1.

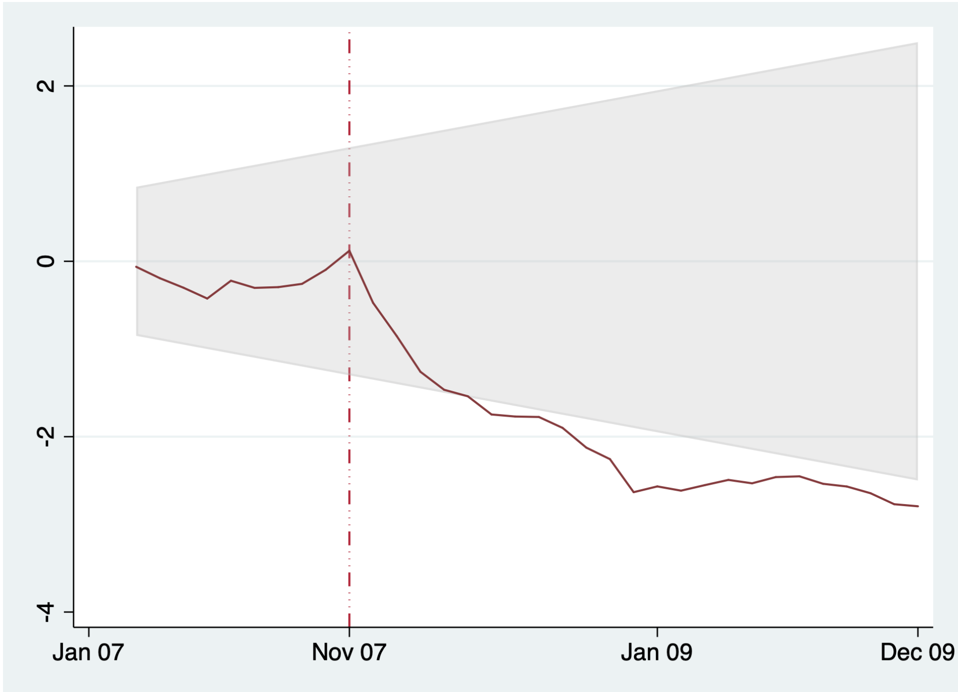


Figure 3.3. Structural Break Test for Average Transaction Price in La Manga Around 2007 Shock. This figure plots the cumulative sum (CUSUM) test for parameter stability. The shaded area is the 95% confidence interval. The vertical dashed-dotted line (November 2007) represents the time of the publication of the 2007 Greenpeace report. The null hypothesis is coefficient constancy. Values outside the confidence area suggest structural change over time. The sample period is from January 2007 to December 2009.

Figure 3.4. Structural Break Test for Average Transaction Price in La Manga Around 2014 Shock. This figure plots the cumulative sum (CUSUM) test for parameter stability. The shaded area is the 95% confidence interval. The vertical dashed-dotted line (April 2014) represents the time of the publication of the 2014 Greenpeace report. The null hypothesis is coefficient constancy. Values outside the confidence area suggest structural change over time. The sample period is from January 2013 to December 2015.

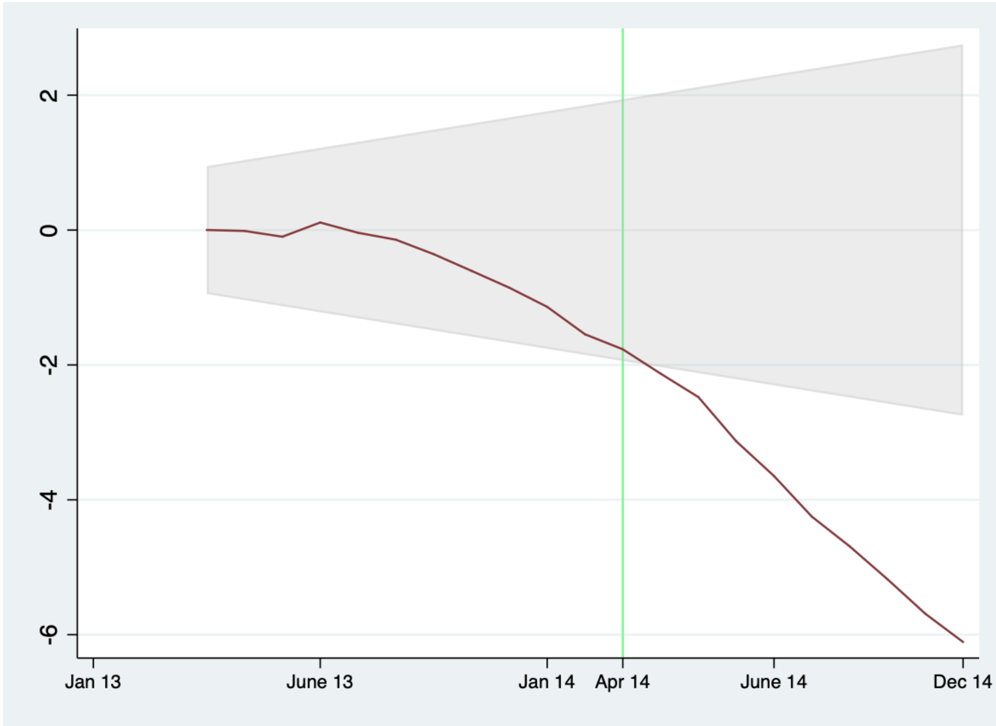


Figure 3.5. Structural Break Test for Listing Price in La Manga Around 2014 Shock. This figure redoes Figure 3.4 but for listing price.

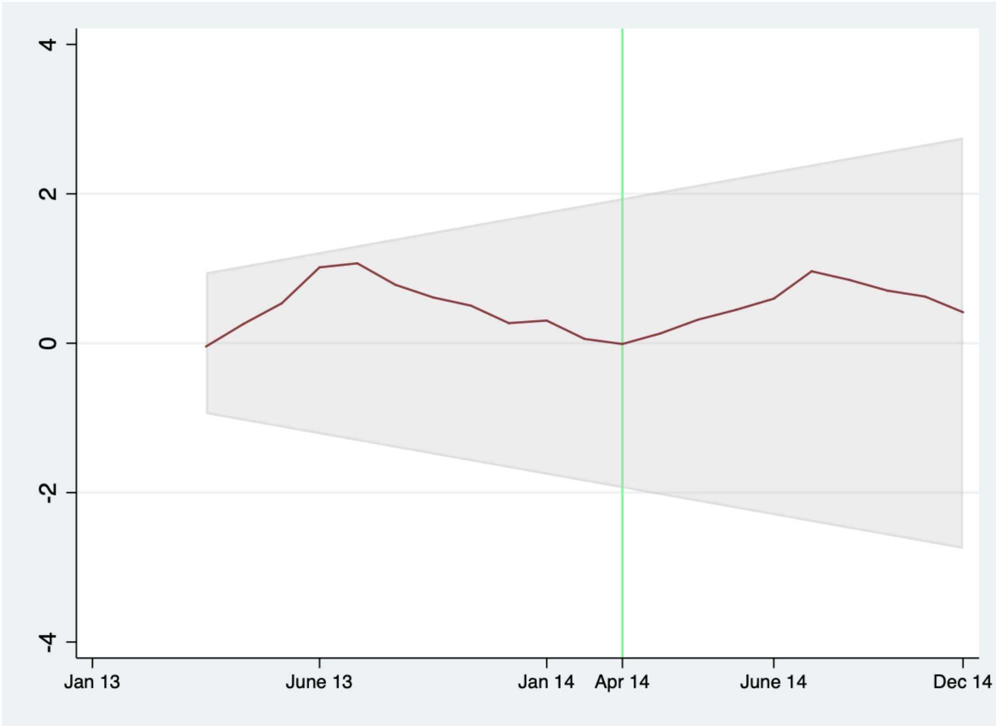


Figure 3.6. Structural Break Test for Housing Rents in La Manga Around 2014 Shock. This figure redoes Figure 3.5 but for housing rents. The figure shows no structural break as discussed in Section 3.3.

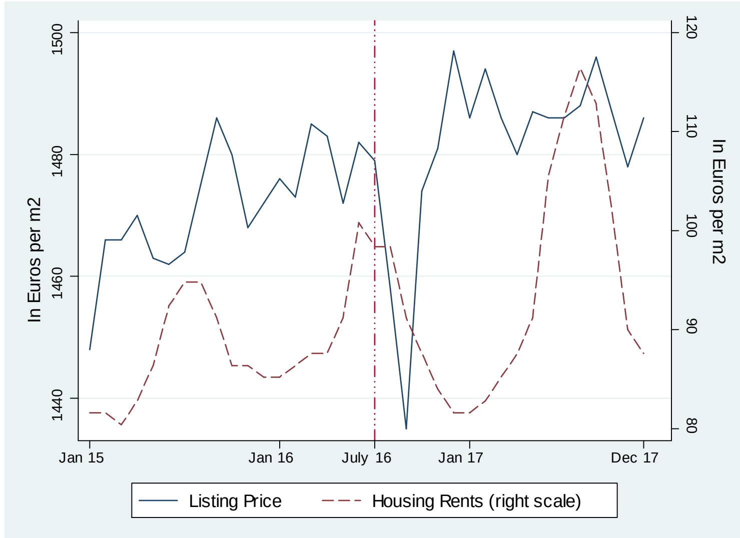


Figure 3.7. Housing Prices and Rents in La Manga: 2016 Algal Bloom. The solid line plots listing price while the dashed line plots housing rents. The vertical dashed-dotted line is the 2016 algal bloom. The sample period is from January 2015 to December 2017.

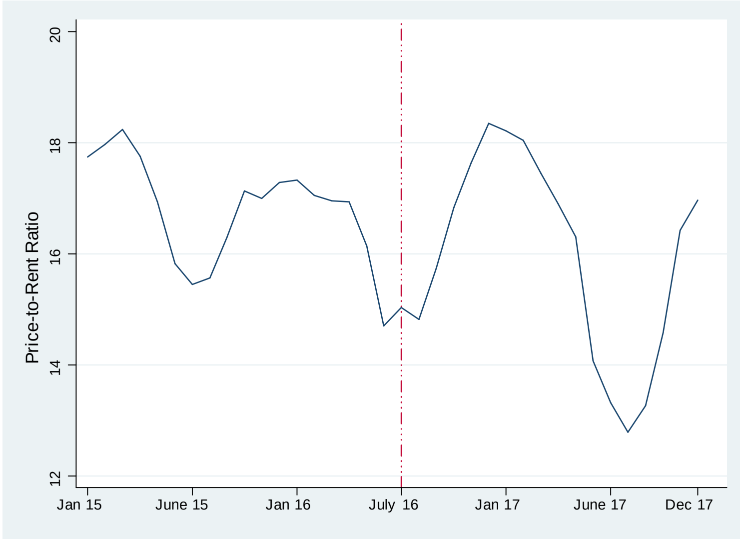


Figure 3.8. Price-to-Rent Ratio in La Manga: Algal Bloom. This figure plots the ratio of monthly listing price to housing rents. The vertical dashed-dotted line and the sample period are as described in Figure 3.7.

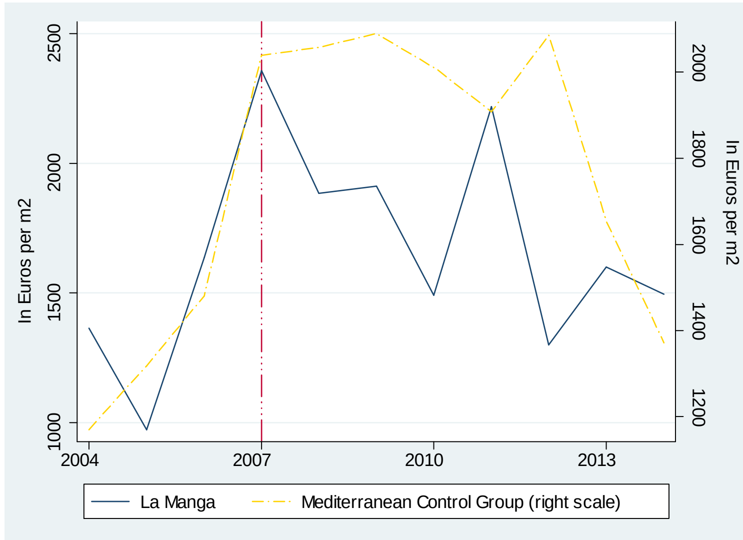


Figure 3.9. Average Transaction Price Around 2007 Shock: La Manga vs. Benchmark Control Group. The solid line plots average transaction price in La Manga. The dashed line plots average transaction price in the benchmark control group as discussed in Section 3.4. The vertical dashed-dotted line represents the 2007 Greenpeace shock and the sample period is 2004-2013.

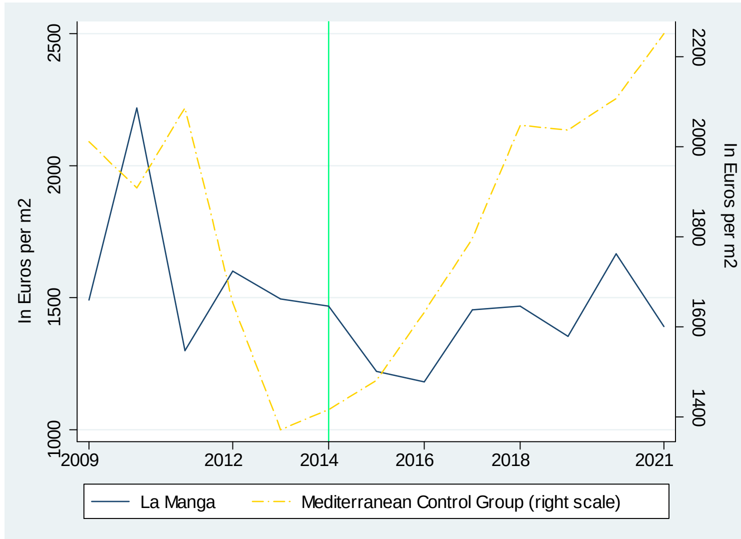


Figure 3.10. Average Transaction Price Around 2014 Shock: La Manga vs. Benchmark Control Group. The solid line plots average transaction price in La Manga. The dashed line plots average transaction price in the benchmark control group as discussed in Section 3.4. The solid vertical line represents the 2014 Greenpeace shock and the sample period is 2009-2021.

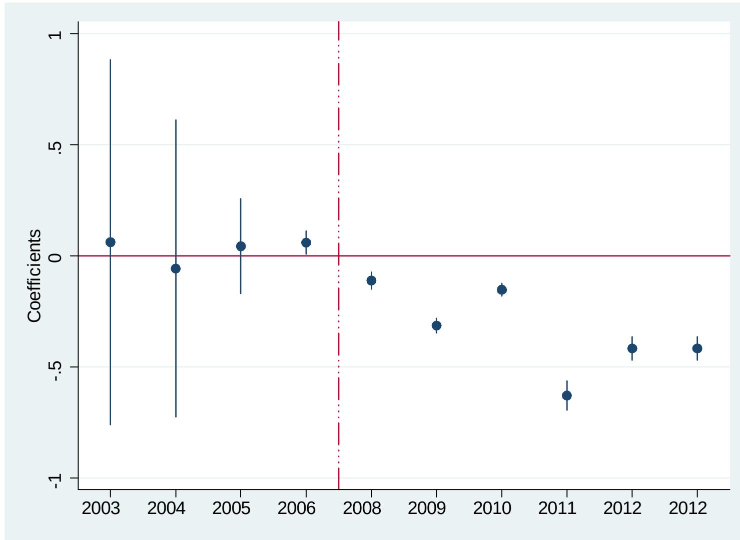


Figure 3.11. Parameter Trend Around 2007 Shock: La Manga vs. Benchmark Control Group. This figure plots the parameter trend for La Manga pre and post 2007 Greenpeace shock relative to the benchmark control group as defined in Section 3.4. The vertical dashed-dotted line represents the 2007 Greenpeace shock and the sample period is 2003-2013.

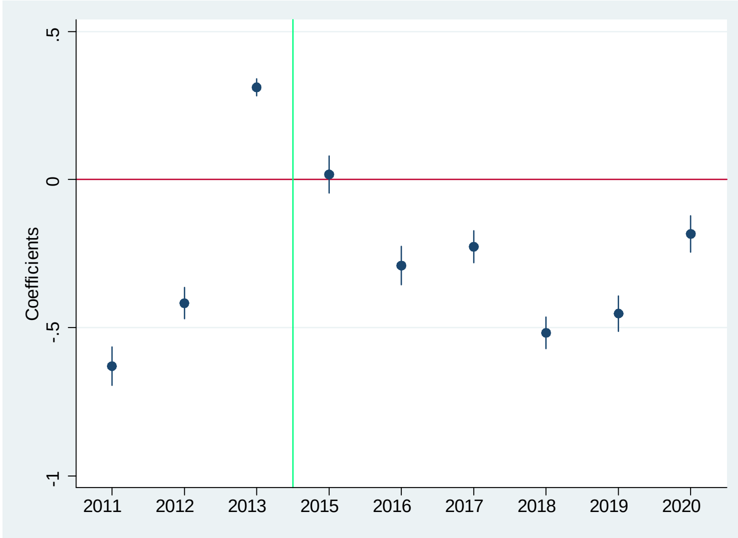


Figure 3.12. Parameter Trend Around 2014 Shock: La Manga vs. Benchmark Control Group. This figure plots the parameter trend for La Manga pre and post 2014 Greenpeace shock relative to the benchmark control group as defined in Section 3.4. The solid vertical line represents the 2014 Greenpeace shock and the sample period is 2011-2021.

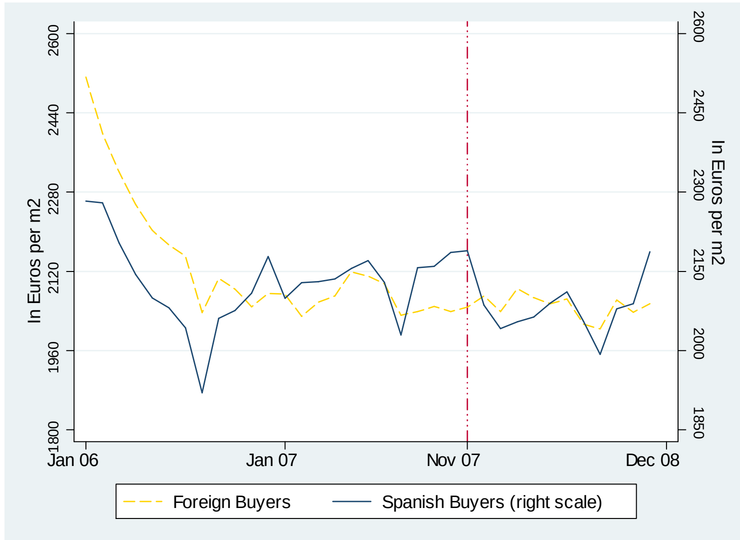


Figure 3.13. Average Transaction Price in La Manga by Buyer Nationality: 2007 Shock. The solid line plots average transaction price paid by Spanish buyers, the dashed line plots the same variable for foreign buyers as discussed in Section 3.5. The vertical dashed-dotted line represents the 2007 Greenpeace shock and the sample period is from 2006-2008.

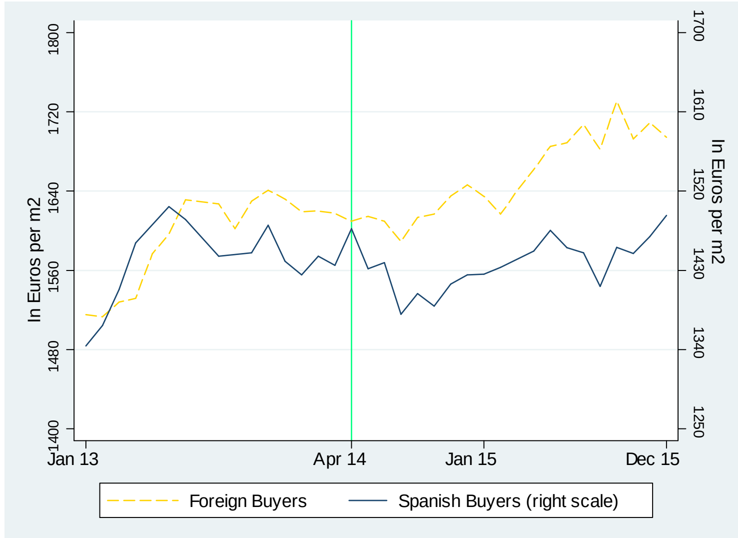


Figure 3.14. Average Transaction Price in La Manga by Buyer Nationality: 2014 Shock. The solid line plots average transaction price paid by Spanish buyers, the dashed line plots the same variable for foreign buyers as discussed in Section 3.5. The vertical line represents the 2014 Greenpeace shock and the sample period is from 2013-2015.

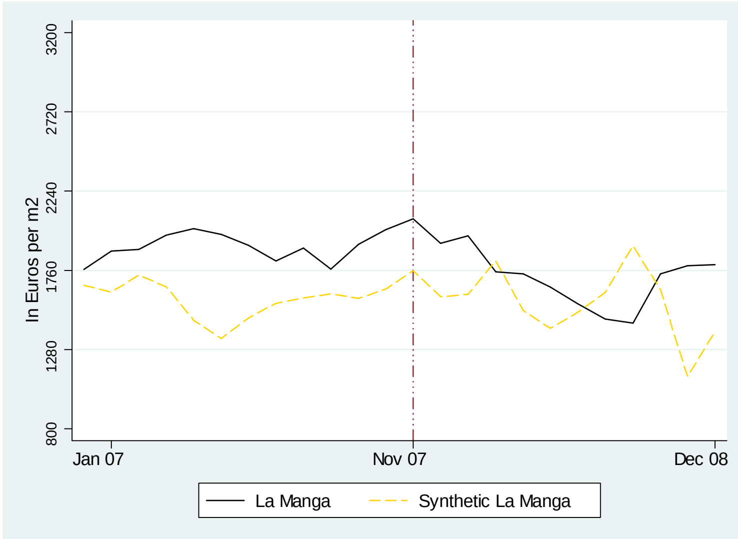


Figure 3.15. Average Transaction Price Around 2007 Shock: La Manga vs. Synthetic Control Group. The solid line plots average transaction price in La Manga. The dashed line plots average transaction price in the synthetic control group as discussed in Section 3.4. The vertical dashed-dotted line represents November 2007 and the sample period is 2007-2009.

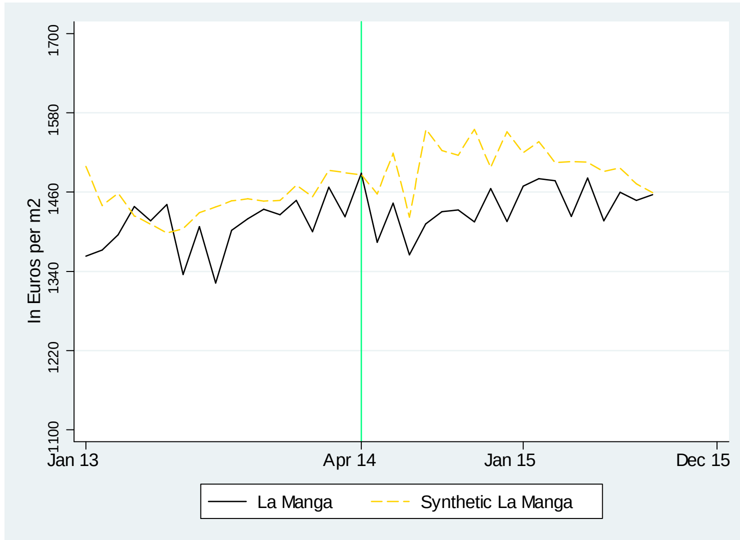


Figure 3.16. Average Transaction Price Around 2014 Shock: La Manga vs. Synthetic Control Group. The solid line plots average transaction price in La Manga. The dashed line plots average transaction price in the synthetic control group as discussed in Section 3.4. The solid vertical line represents April 2014 and the sample period is 2013-2015.

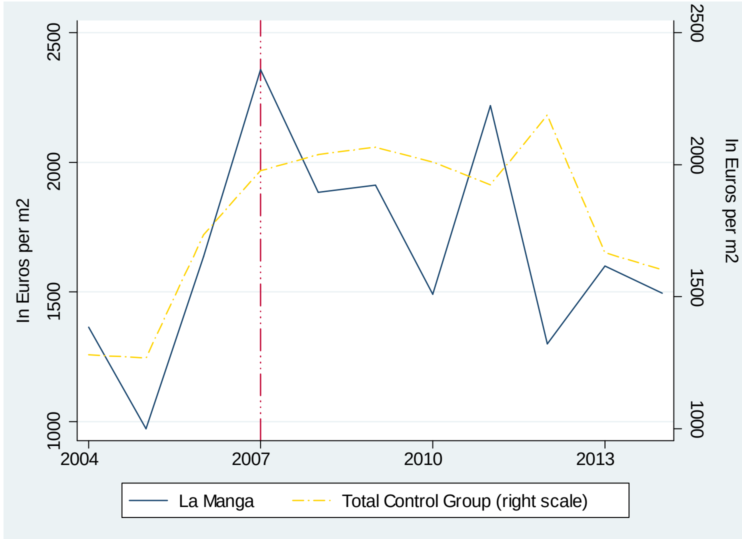


Figure 3.17. Average Transaction Price Around 2007 Shock: La Manga vs. Total Control Group. The solid line plots average transaction price in La Manga. The dashed line plots average transaction price in the total control group as discussed in Section 3.4. The vertical dashed-dotted line represents 2007 and the sample period is 2004-2013.

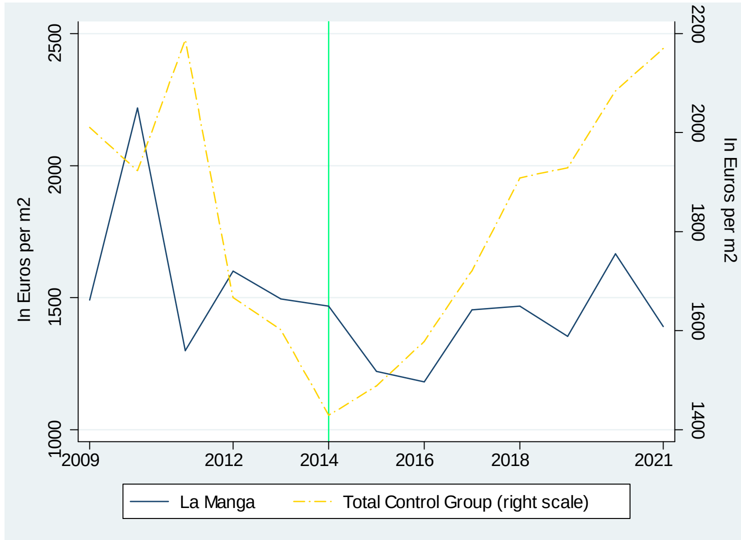


Figure 3.18. Average Transaction Price Around 2014 Shock: La Manga vs. Total Control Group. The solid line plots average transaction price in La Manga. The dashed line plots average transaction price in the total control group as discussed in Section 3.4. The solid vertical line represents 2014 and the sample period is 2009-2021.

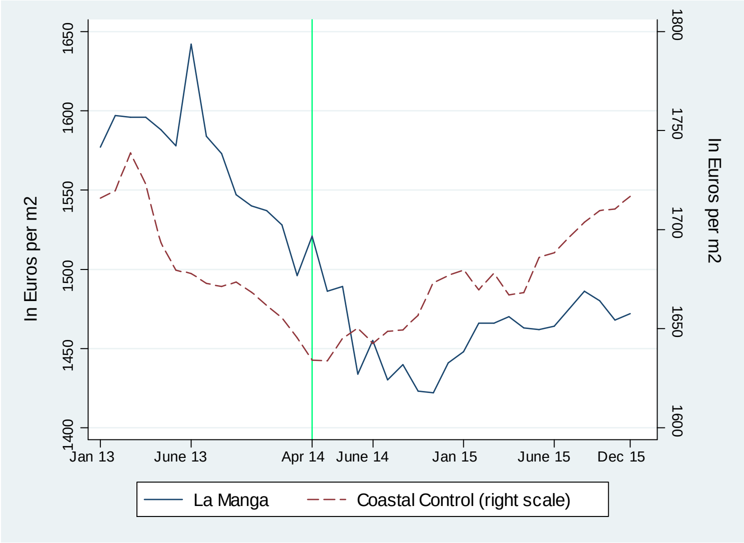


Figure 3.19. Listing Price Around 2014 Shock: La Manga vs. Coastal Control Group. The solid line plots listing price in La Manga. The dashed line plots the listing price in the coastal control group discussed in Section 3.4. The solid vertical line represents the 2014 Greenpeace shock and the sample period is 2013-2015.

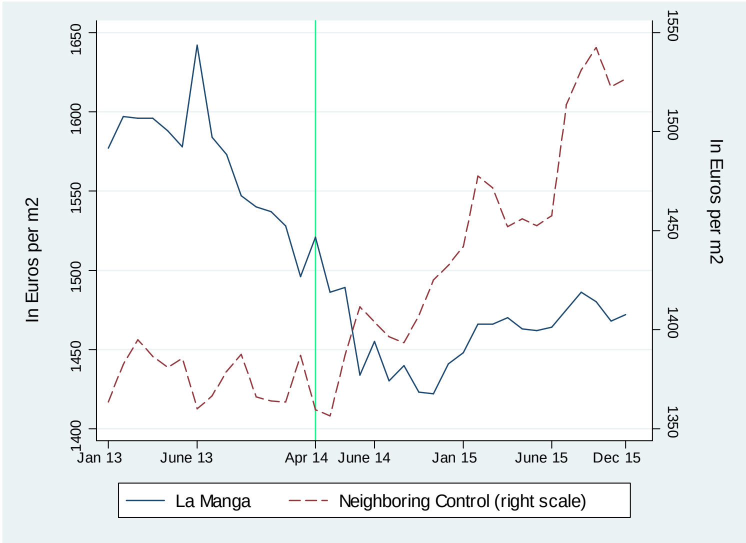


Figure 3.20. Listing Price Around 2014 Shock: La Manga vs. Neighboring Control Group. The solid line plots listing price in La Manga. The dashed line plots listing price in the neighboring locations discussed in Section 3.4. The vertical line and the sample period are as described in Figure 3.1.

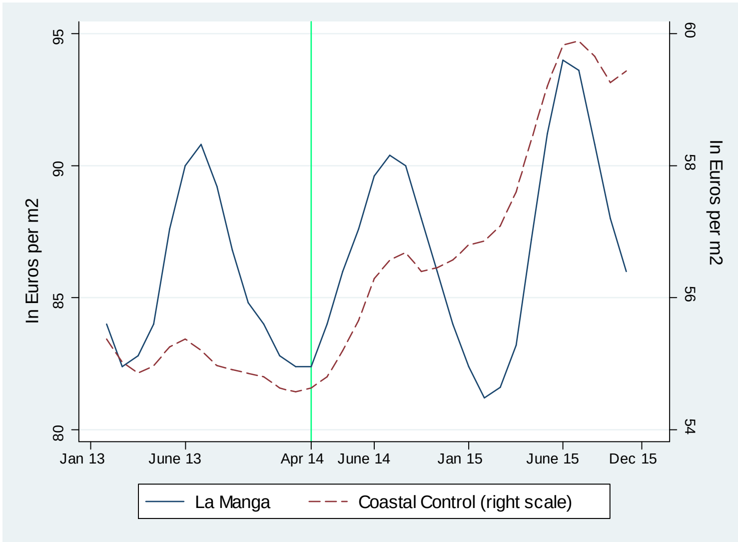


Figure 3.21. Housing Rents in La Manga and in the Coastal Control Group. The solid line plots housing rents in La Manga. The dashed line plots the housing rents in the coastal control group discussed in Section 3.4. The vertical line and the sample period are as described in Figure 3.1.

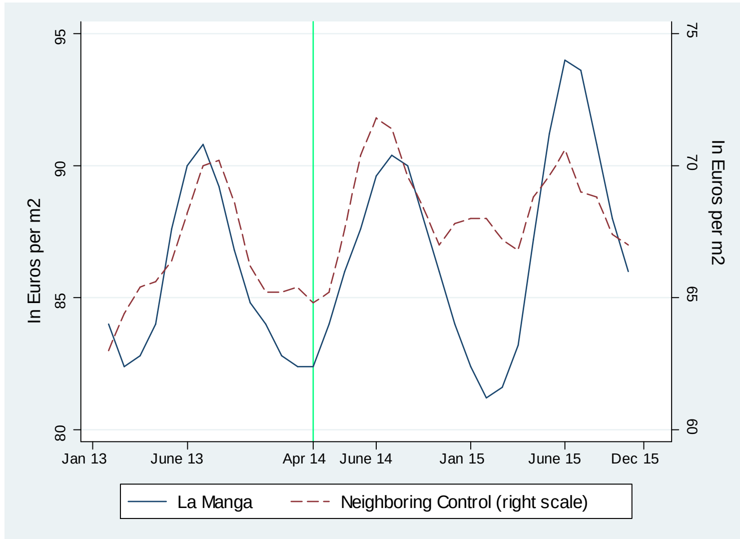


Figure 3.22. Housing Rents in La Manga and in the Neighboring Control Group. The solid line plots housing rents in La Manga. The dashed line plots housing rents in the neighboring control group discussed in Section 3.4. The vertical line and the sample period are as described in Figure 3.1.

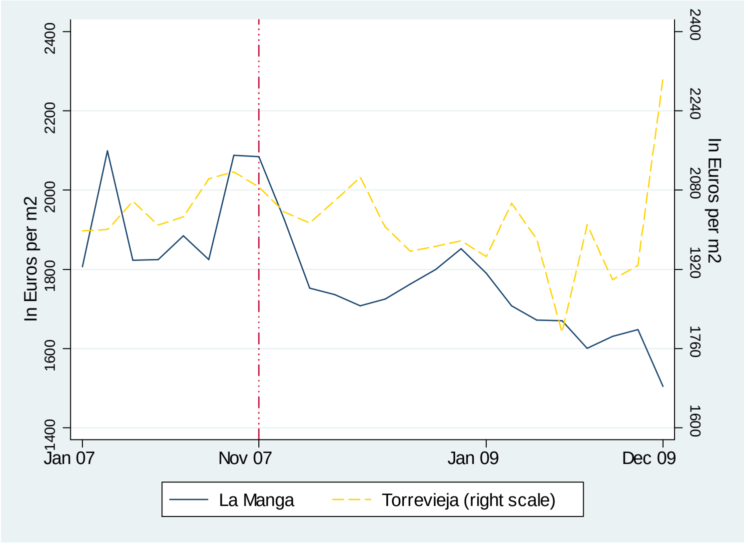


Figure 3.23. Average Transaction Price in La Manga and in Torrevieja: 2007 Shock. The solid line plots average transaction price in La Manga. The dashed line plots average transaction price in Torrevieja, which is a control group used by Bank of Spain (2021). The vertical dashed-dotted line represents the 2007 shock (November 2007) and the sample period consists of 2007-2009.

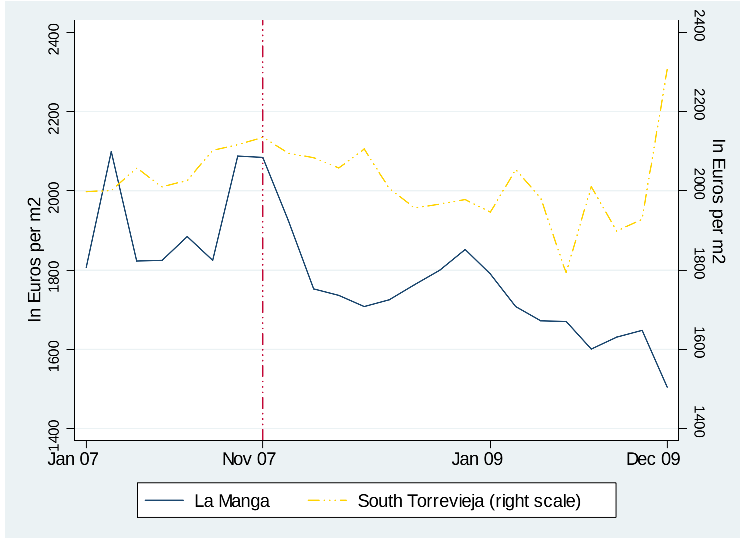


Figure 3.24. Average Transaction Price in La Manga and in South Torrevieja: 2007 Shock. The solid line plots average transaction price in La Manga. The dashed line plots average transaction price in South Torrevieja, which is a control group used by Bank of Spain (2021). The vertical dashed-dotted line and the sample period are as described in Figure 3.23.

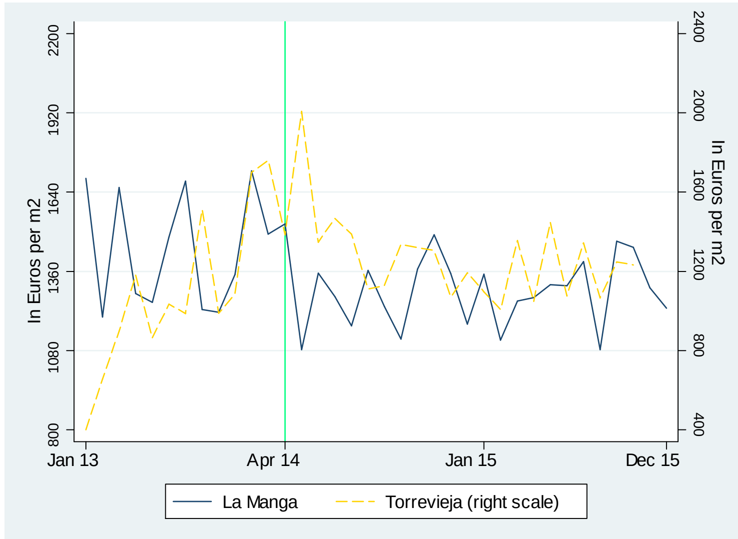


Figure 3.25. Average Transaction Price in La Manga and in Torrevieja: 2014 Shock. The solid line plots average transaction price in La Manga. The dashed line plots average transaction price in Torrevieja, which is a control group used by Bank of Spain (2021). The solid vertical line and the sample period are as described in Figure 3.1.

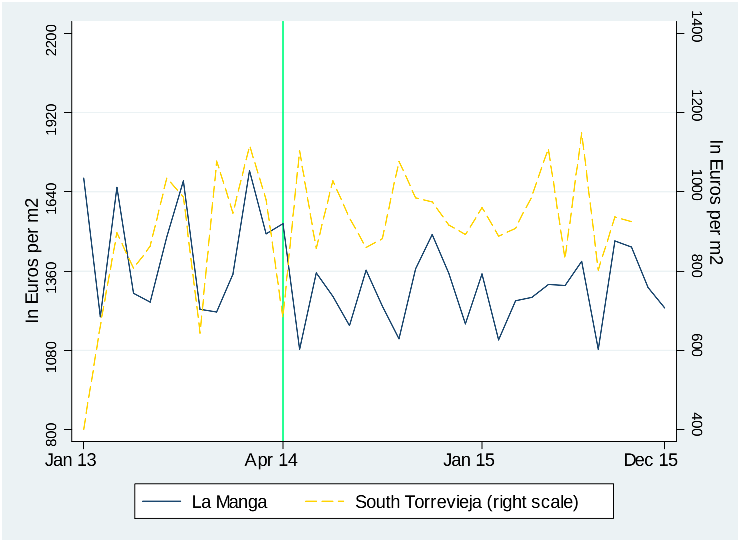


Figure 3.26. Average Transaction Price in La Manga and in South Torrevieja: 2014 Shock. The solid line plots average transaction price in La Manga. The dashed line plots average transaction price in South Torrevieja, which is a control group used by Bank of Spain (2021). The solid vertical line and the sample period are as described in Figure 3.1.

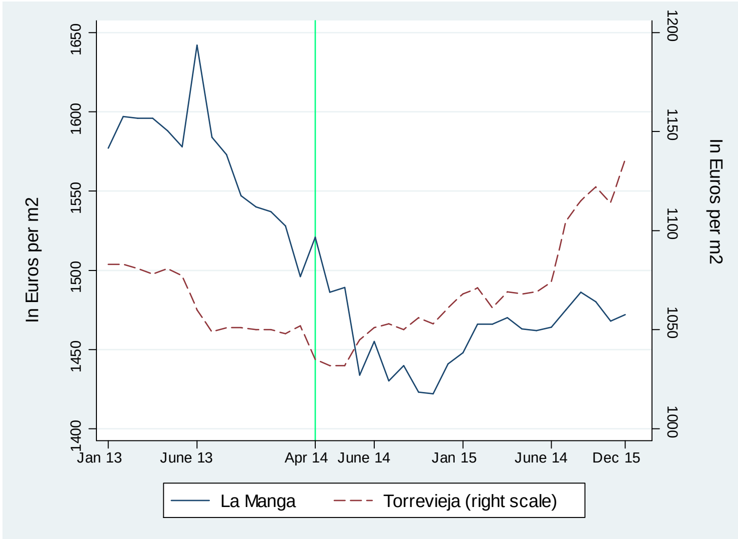


Figure 3.27. Listing Price in La Manga and in Torrevieja. The solid line plots listing price in La Manga. The dashed line plots housing prices in Torrevieja, which is a control group used by Bank of Spain (2021). The solid vertical line and the sample period are as described in Figure 3.1.

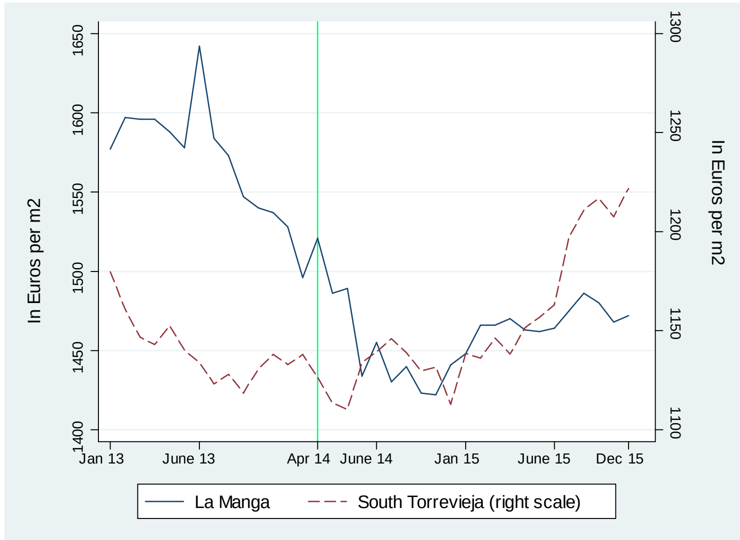


Figure 3.28. Listing Prices in La Manga and in South Torrevieja. The solid line plots the listing prices in La Manga. The dashed line plots housing prices in South Torrevieja, which is a control group used by Bank of Spain (2021). The solid vertical line and the sample period are as described in Figure 3.1.

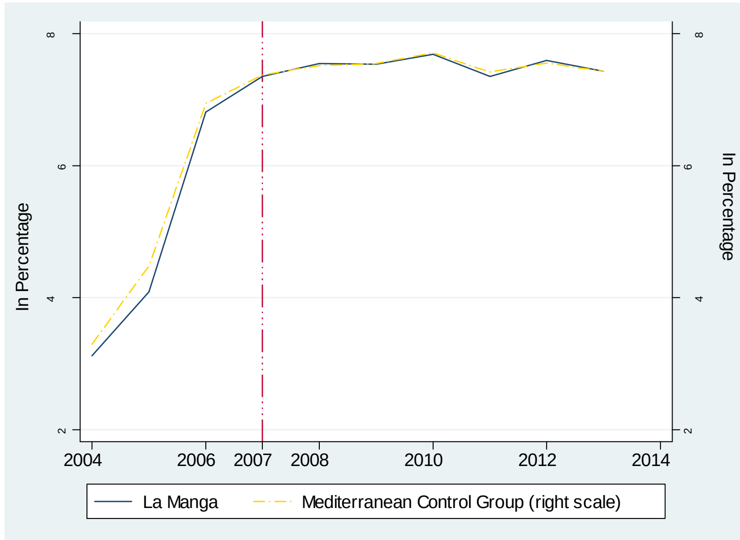


Figure 3.29. Transaction Number Around 2007 Shock: La Manga vs. Benchmark Control Group. The solid line plots transaction number in La Manga. The dashed line plots transaction number in the benchmark control group as discussed in Section 3.4. The vertical dashed-dotted line represents the 2007 Greenpeace shock and the sample period is 2004-2013.

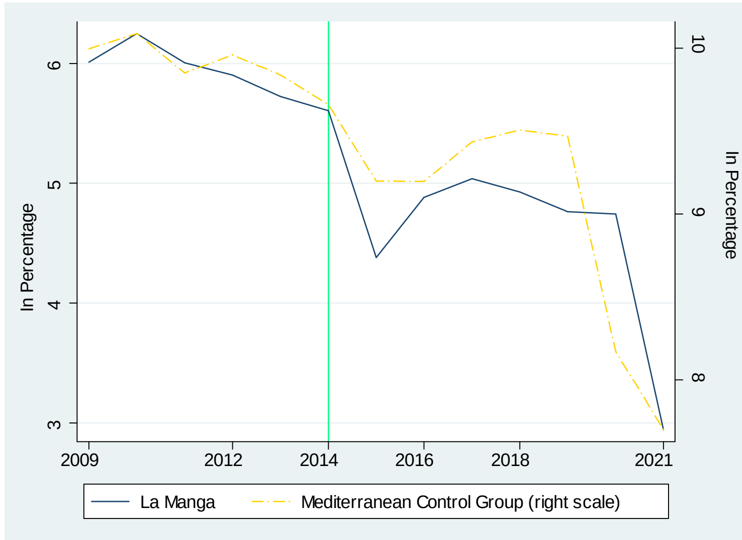


Figure 3.30. Transaction Number Around 2014 Shock: La Manga vs. Benchmark Control Group. The solid line plots transaction number in La Manga. The dashed line plots transaction number in the benchmark control group as discussed in Section 3.4. The solid vertical line represents the 2014 Greenpeace shock and the sample period is 2009-2021.

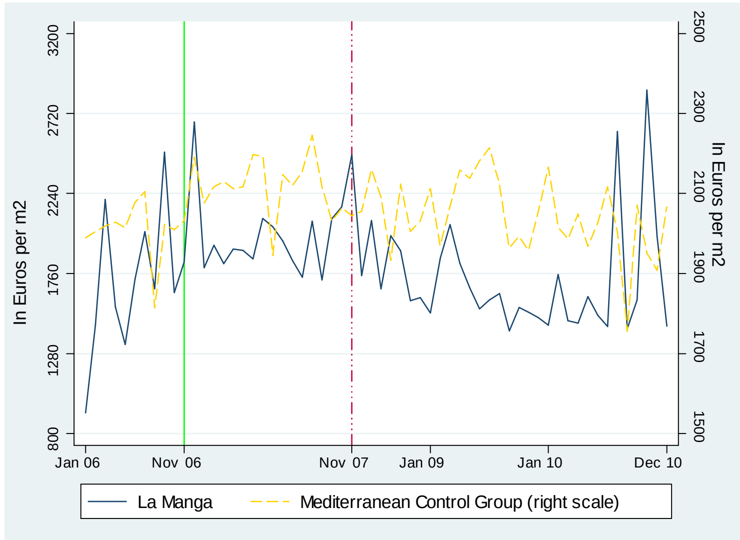


Figure 3.31. Comparing Placebo and The 2007 Shock with Mediterranean Control Group. This figure plots average transaction price in La Manga (solid line) and in the benchmark Mediterranean control group as discussed in Section 3.4 (dashed line). The first vertical line (November 2006) is the placebo shock discussed in Section 3.6 while the second vertical dashed-dotted line (November 2007) represents the actual 2007 Greenpeace shock. The sample period is from January 2006 to December 2010.

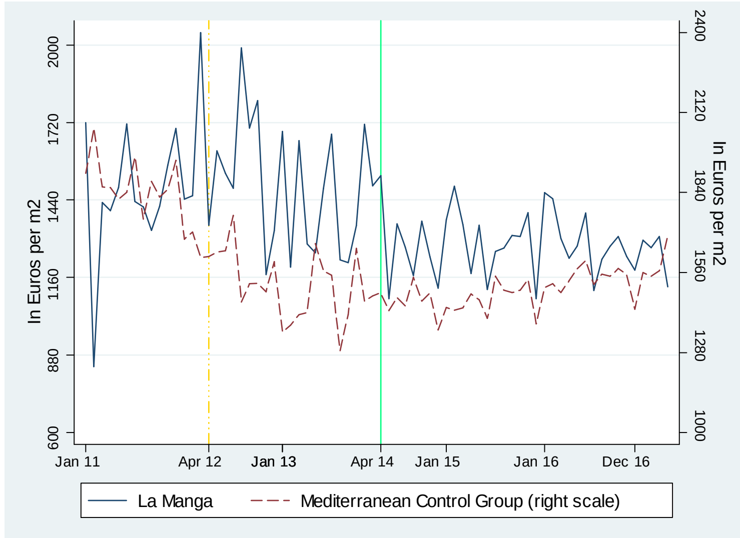


Figure 3.32. Comparing Placebo and The 2014 Shock with Mediterranean Control Group. This figure plots average transaction price in La Manga (solid line) and in the benchmark Mediterranean control group as discussed in Section 3.4 (dashed line). The first dashed-dotted vertical line (April 2012) is the placebo shock discussed in Section 3.6 while the solid line (April 2014) represents the actual 2014 Greenpeace shock. The sample period is from January 2011 to December 2016.

Figure 3.33. Comparing Placebo and Actual Shocks with the Coastal Control Group. This figure plots listing price in La Manga (solid line) and in the coastal control group discussed in Section 3.4 (dashed line). The first vertical dashed-dotted line (April 2012) is the placebo shock discussed in Section 3.6 while the solid line (April 2014) is the actual 2014 Greenpeace shock. The sample period is from January 2011 to December 2016.

Figure 3.34. Comparing Placebo and Actual Shocks with the Neighboring Control Group. This figure redoes Figure 3.33 but for the neighboring control group (dashed line) discussed in Section 3.4.

3.10 Tables

Table 3.8. Wald Test for Structural Break Around 2007 Shock

	Transaction Price
Chi-Square	46.80***
	(0.000)
Observations	36

Note: This table does a structural break analysis using a Wald test with known break date (November 2007 when the Greenpeace report was published). The null hypothesis is no structural break at the specified breakpoint (i.e., November 2007). The sample consists of monthly observations from January 2007 to December 2009. P-values are in parentheses. *** means significant at 1% level.

Table 3.9. Wald Test for Structural Break Around 2014 Shock

	Transaction Price	Listing Price	Housing Rents
Chi-Square	27.68***	65.17***	1.23
	(0.000)	(0.000)	(0.541)
Observations	36	36	36

Note: This table does a structural break analysis using a Wald test with known break date (April 2014 when the Greenpeace report was published). The null hypothesis is no structural break at the specified breakpoint (i.e., April 2014). The sample consists of monthly observations from January 2013 to December 2015. P-values are in parentheses. *** means significant at 1% level.

Table 3.10. Testing the Equality of Pre Shock Means: Average Transaction Price

	Greenpeace Shocks							
	2007				2014			
Variables	Obs.	La Manga	Control	t-stat	Obs.	La Manga	Control	t-stat
Transaction Price Growth	21	7.50	7.63	2.66	15	7.24	7.29	1.05
Inflation Rate	21	0.10	0.13	0.22	15	0.37	0.08	-0.06
Unemployment Growth	21	2.82	4.52	1.24	15	-0.91	-3.55	-13.50*
Population Growth	21	.20	0.04	-3.10*	15	.42	-0.06	-15.57*

Note: This table tests the equality of the means of the key variables in the pre shock period. The null hypothesis is that the means of these variables are equal between the treatment and the control groups. All variables are monthly growth rates in percentage. The control groups are defined in Section 3.4. The sample goes from January 2006 to November 2007 for '07 Shock and from January 2013 to April 2014 for '14 Shock. * means significant at 10% level.

Table 3.11. Testing the Equality of Pre Shock Means Around 2014 Shock: Listing Price and Housing Rents

	Treatment		Control Groups					
	La Manga		Coastal			Neighboring		
Variables	Obs.	Mean	Obs.	Mean	t-stat	Obs.	Mean	t-stat
Listing Price Growth	16	-0.36	80	-0.38	-0.05	32	-0.10	0.50
Housing Rent Growth	16	-0.05	75	-0.12	-0.14	32	0.21	0.24
Inflation Rate	16	0.01	80	0.00	-0.05	32	0.00	-0.06
Population Growth	16	-0.02	80	-0.06	-0.49	32	0.04	1.85*

Note: This table tests the equality of the means of the key variables in the pre shock period. The null hypothesis is that the means of these variables are equal between the treatment and the control groups. All variables are monthly growth rates in percentage. The control groups are defined in Section 3.6. The sample goes from the first quarter of 2013 to the first quarter of 2014. * means significant at 10% level.

Table 3.12. Summary Statistics for Diff-in-diff Analysis

	Observations	Mean	SD	Min.	Max.
Main Variables					
Transaction Price	1,846,378	1857.29	308.35	312.24	8445.89
Listing Price	288	1591.02	406.20	1032.00	2496.00
Housing Rents	288	77.07	12.02	54.00	115.20
Control Variables					
Sea Level	1,846,378	19.86	0.68	19.10	21.19
Consumer Price Index (CPI)	1,846,378	100.73	0.69	98.62	101.92
Population (in thousands)	1,846,378	153.91	185.82	15.59	569.13
Unemployment Rate (in %)	1,846,378	23.25	3.15	16.74	27.55

Note. Housing prices and housing rents are in Euros per square meter. Sea Level is the global sea level measured in centimeters. CPI is an index with value 100 in 2016.

Table 3.13. Log of Average Transaction Price: La Manga vs. Mediterranean Control Group

	(1)	(2)
La Manga×Postreport	-0.11***	-0.15***
	(0.00)	(0.00)
Economic Controls	Yes	Yes
Other Controls	Yes	Yes
Observations	783,143	523,931
R-squared	0.14	0.13

Note: This table estimates Equation 3.1 with log of average transaction price as the dependent variable. P-values are in parentheses. The economic controls and other controls are as in Table 3.5. The independent variable is the interaction term (LaManga×PostReport) that takes the value of one for observations in La Manga post November 2007, and zero otherwise. The sample consists of daily observations from January 2004 to December 2013 for Column 1 and from January 2009 to December 2021 for Column 2. *** means significant at 1%. The Mediterranean control group is as defined in Section 3.4. All specifications use robust standard errors.

Table 3.14. Average Transaction Price In La Manga: Spanish vs. Foreign Buyers

	'07 Shock	'14 Shock
Spanish×PostReport	-0.04***	-0.02***
	(0.00)	(0.00)
Observations	1,870	2,352
R-squared	0.01	0.01

Note: This table estimates Equation 3.2 with log of average transaction price in La Manga as the dependent variable. P-values are in parentheses. Spanish and foreign buyers are as defined in Section 3.5. The independent variable represents Spanish buyers post the two Greenpeace shocks as described in Section 3.5. The sample period for the first column consists of monthly data from January 2007 to December 2009. The sample period for the second column consists of monthly data from January 2013 to December 2015. *** indicates significance at 1% level. All specifications use robust standard errors.

Table 3.15. Log of Average Transaction Price: La Manga vs. Synthetic Control Group

	(1)	(2)
La Manga×Postreport	-0.10***	-0.16***
	(0.00)	(0.00)
Economic Controls	Yes	Yes
Other Controls	Yes	Yes
Observations	71	72
R-squared	0.47	0.82

Note: This table estimates Equation 3.1 with log of average transaction price as the dependent variable. P-values are in parentheses. The economic controls and other controls are as in Table 3.5. The independent variable is the interaction term (LaManga×PostReport) that takes the value of one for observations in La Manga post Greenpeace shock periods, and zero otherwise. The sample consists of average monthly observations from January 2007 to December 2009 for Column 1 and from January 2013 to December 2015 for Column 2. *** means significant at 1%. The synthetic control group is as defined in Section 3.4. All specifications use robust standard errors.

Table 3.16. Log of Average Transaction Price: La Manga vs. Total Control Group

	(1)	(2)
La Manga×Postreport	-0.19***	-0.04**
	(0.00)	(0.00)
Economic Controls	Yes	Yes
Other Controls	Yes	Yes
Observations	119,280	122,089
R-squared	0.24	0.16

Note: This table estimates Equation 3.1 with log of average transaction price as the dependent variable. P-values are in parentheses. The economic controls and other controls are as in Table 3.5. The independent variable is the interaction term (LaManga×PostReport) that takes the value of one for observations in La Manga post Greenpeace shock periods, and zero otherwise. The sample consists of daily observations from January 2004 to December 2013 for Column 1 and from January 2009 to December 2021 for Column 2. *** means significant at 1%. and ** means significant at 5%. The total control group is as defined in Section 3.4. All specifications use robust standard errors.

Table 3.17. Log of Listing Prices 2013-15

	Coastal	Neighboring
La Manga×PostReport	–0.07***	-0.05**
	(0.00)	(0.02)
Economic Controls	Yes	Yes
Other Controls	Yes	Yes
Observations	216	108
R-squared	0.77	0.84

Note: This table estimates Equation 3.1 with log of listing price as the dependent variable. P-values are in parentheses. The economic controls and other controls are as in Table 3.5. The independent variable is the interaction term (LaManga×PostReport) that takes the value of one for observations in La Manga post April 2014, and zero otherwise. The sample consists of monthly observations from January 2013 to December 2015. *** and ** mean significant at 1% and 5% level respectively. The control groups are as defined in Section 3.4. All specifications use robust standard errors.

Table 3.18. Log of Housing Rents 2013-15

	Coastal	Neighboring
La Manga×PostReport	–0.16	0.08***
	(0.34)	(0.00)
Economic Controls	Yes	Yes
Other Controls	Yes	Yes
Observations	216	108
R-squared	0.85	0.78

Note: This table estimates Equation 3.2 with log of housing rents as the dependent variable. P-values are in parentheses. The economic controls and other controls are as in Table 3.5. The independent variable is the interaction term (LaManga×PostReport) that takes the value of one for observations in La Manga post April 2014, and zero otherwise. The sample consists of monthly observations from January 2013 to December 2015. *** means significant at 1% level. The control groups are as defined in Section 3.4. All specifications use robust standard errors.

Table 3.19. **Log of Average Transaction Price 2007-09 with Other Control Groups**

	Torrevieja	South Torrevieja
La Manga×PostReport	–0.15***	-0.24***
	(0.00)	(0.00)
Economic Controls	Yes	Yes
Other Controls	Yes	Yes
Observations	254	247
R-squared	0.07	0.65

Note: This table estimates Equation 3.1 and uses log of average transaction price as the dependent variable. P-values are in parentheses. The economic controls and other controls are as in Table 3.5. The independent variable is the interaction term (LaManga×PostReport) that takes the value of one for observations in La Manga post November 2007, and zero otherwise. The sample consists of monthly observations from January 2013 to December 2015. *** means significant at 1% level. The control groups are as defined in Section 3.6. All specifications use robust standard errors.

Table 3.20. Log of Average Transaction Price 2013-15 with Other Control Groups

	Torrevieja	South Torrevieja
La Manga×PostReport	–0.06***	-0.07***
	(0.00)	(0.00)
Economic Controls	Yes	Yes
Other Controls	Yes	Yes
Observations	797	679
R-squared	0.32	0.26

Note: This table estimates Equation 3.1 and uses log of average transaction price as the dependent variable. P-values are in parentheses. The economic controls and other controls are as in Table 3.5. The independent variable is the interaction term (LaManga×PostReport) that takes the value of one for observations in La Manga post April 2014, and zero otherwise. The sample consists of monthly observations from January 2013 to December 2015. *** means significant at 1% level. The control groups are as defined in Section 3.6. All specifications use robust standard errors.

Table 3.21. Log of Listing Price 2013-15 with Other Control Groups

	Torrevieja	South Torrevieja
La Manga×PostReport	–0.09***	-0.10***
	(0.00)	(0.00)
Economic Controls	Yes	Yes
Other Controls	Yes	Yes
Observations	72	180
R-squared	0.99	0.65

Note: This table estimates Equation 3.1 and uses log of listing price as the dependent variable. P-values are in parentheses. The economic controls and other controls are as in Table 3.5. The independent variable is the interaction term (LaManga×PostReport) that takes the value of one for observations in La Manga post April 2014, and zero otherwise. The sample consists of monthly observations from January 2013 to December 2015. *** means significant at 1% level. The control groups are as defined in Section 3.6. All specifications use robust standard errors.

Table 3.22. Log of Transaction Number: La Manga vs. Mediterranean Control Group

	'07 Shock	'14 Shock
La Manga×PostReport	-0.01	-0.09***
	(0.53)	(0.00)
Economic controls	Yes	Yes
Other controls	Yes	Yes
Observations	65,308	72,616
R-squared	0.15	0.14

Note: This table estimates Equation 3.1 with log of transaction number as the dependent variable. P-values are in parentheses. The economic controls and other controls are as in Table 5. The independent variable is the interaction term (LaManga×PostReport) that takes the value of one for observations in La Manga post November 2007, and zero otherwise. The sample consists of daily observations from January 2004 to December 2013 for Column 1 and from January 2009 to December 2021 for Column 2. *** means significant at 1%. The Mediterranean control group is as defined in Section 3.4. All specifications use robust standard errors.

Table 3.23. Log of Average Transaction Price with Placebo Shocks

	'06 Placebo	'12 Placebo
La Manga×PostReport	-0.02	0.03**
	(0.88)	(0.04)
Economic Controls	Yes	Yes
Other Controls	Yes	Yes
Observations	88,749	88,749
R-squared	0.22	0.22

Note: This table estimates Equation 3.1 and uses log of average transaction price as the dependent variable. P-values are in parentheses. The economic controls and other controls are as in Table 5. The independent variable is the interaction term (LaManga×PostReport) that takes the value of one for observations in La Manga post November 2006 in the first column and post April 2012 in the second column, and zero otherwise. The samples consist of monthly observations from January 2006 to December 2008 for the first column and January 2011 to December 2013 for the second column. ** means significant at 5% level. The control group is as defined in Section 3.4. All specifications use robust standard errors.

Table 3.24. Log of Listing Price with 2012 Placebo Shock

	Coastal	Neighboring
La Manga×PostReport	0.04	0.11**
	(0.10)	(0.03)
Economic Controls	Yes	Yes
Other Controls	Yes	Yes
Observations	216	108
R-squared	0.81	0.75

Note: This table estimates Equation 3.1 and uses log of listing price as the dependent variable. P-values are in parentheses. The economic controls and other controls are as in Table 5. The independent variable is the interaction term (LaManga×PostReport) that takes the value of one for observations in La Manga post April 2012, and zero otherwise. The sample consists of monthly observations from January 2011 to December 2013. ** means significant at 5% level. The control groups are as defined in Section 3.4. All specifications use robust standard errors.

APPENDIX

Figures

Panel A

Panel B

Figure 3.A1. La Manga Aerial View and Map. Panel A is an aerial view of La Manga while Panel B shows the map of La Manga.

Figure 3.A2. Greenpeace Inundation Projections for La Manga. This figure shows the projections for inundations in La Manga according to Greenpeace.

References

Abadie, A., Diamond, A. and Hainmueller, J.: 2010, Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program, *Journal of the American Statistical Association* **105**(490), 493–505.

Abadie, A. and Gardeazabal, J.: 2003, The economic costs of conflict: A case study of the Basque Country, *American Economic Review* **93**(1), 113–132.

Agarwal, S. and Ben-David, I.: 2018, Loan prospecting and the loss of soft information, *Journal of Financial Economics* **129**(3), 608–628.

Agarwal, S., Chomsisengphet, S., Mahoney, N. and Stroebel, J.: 2018a, Do banks pass through credit expansions to consumers who want to borrow?, *The Quarterly Journal of Economics* **133**(1), 129–190.

Agarwal, S., Chomsisengphet, S., Mahoney, N. and Stroebel, J.: 2018b, Do banks pass through credit expansions to consumers who want to borrow?, *The Quarterly Journal of Economics* **133**(1), 129–190.

Agarwal, S., Deng, Y., Gu, Q., He, J., Qian, W. and Ren, Y.: 2019, Mortgage debt, hand-to-mouth households, and monetary policy transmission, *Hand-to-Mouth Households, and Monetary Policy Transmission (January 29, 2019)* .

Agarwal, S., Yu, Q., Sing, T. F. and Zhan, C.: 2021, Does climate change affect real estate? Evidence from government announcement.

Aoki, M.: 1980, A model of the firm as a stockholder-employee cooperative game, *The American Economic Review* **70**(4), 600–610.

Bakkensen, L. and Barrage, L.: 2021, Going underwater? Flood risk belief heterogeneity and coastal home price dynamics, *The Review of Financial Studies* .

Baldauf, M., Garlappi, L. and Yannelis, C.: 2020, Does climate change affect real estate prices? Only if you believe in it, *The Review of Financial Studies* **33**(3), 1256–1295.

Banco de España: 2021, The value of housing and ecological degradation: The case of the Mar

Menor, *Financial Stability Report* pp. 112–114.

Barsky, R. B. and Sims, E. R.: 2020, News shocks and business cycles, *Journal of Monetary Economics* **58**(3), 273–289.

Beaudry, P. and Portier, F.: 2006, Stock prices, news, and economic fluctuations, *American Economic Review* **96**(4), 1293–1307.

Bebchuk, L. A. and Goldstein, I.: 2011, Self-fulfilling credit market freezes, *Review of Financial Studies* **24**(11), 3519–3555.

Berger, P. G., Ofek, E. and Yermack, D. L.: 1997, Managerial entrenchment and capital structure decisions, *The Journal of Finance* **52**(4), 1411–1438.

Bernanke, B. S., Gertler, M. and Gilchrist, S.: 1999, The financial accelerator in a quantitative business cycle framework, *Handbook of Macroeconomics* **1**, 1341–1393.

Bernstein, A., Gustafson, M. T. and Lewis, R.: 2019, Disaster on the horizon: The price effect of sea level rise, *Journal of Financial Economics* **134**(2), 253–272.

Bertrand, M. and Mullainathan, S.: 2001, Are CEOs rewarded for luck? The ones without principals are, *Quarterly Journal of Economics* pp. 901–932.

Bettis, C., Bizjak, J., Coles, J. and Kalpathy, S.: 2010, Stock and option grants with performance-based vesting provisions, *Review of Financial Studies* p. hhq060.

Bolton, P., Mehran, H. and Shapiro, J.: 2015, Executive compensation and risk taking, *Review of Finance* **19**(6), 2139–2181.

Bryan, S., Hwang, L. and Lilien, S.: 2000, CEO stock-based compensation: An empirical analysis of incentive-intensity, relative mix, and economic determinants, *The Journal of Business* **73**(4), 661–693.

Carlson, M. and Lazrak, A.: 2010, Leverage choice and credit spreads when managers risk shift, *The Journal of Finance* **65**(6), 2323–2362.

Chakraborti, R., Dahiya, S., Ge, L. and Gete, P.: 2021, Credit stimulus, executive ownership, and firm leverage, *Management Science* .

Chen, Q., Chen, X., Schipper, K., Xu, Y. and Xue, J.: 2012, The sensitivity of corporate cash holdings to corporate governance, *Review of Financial Studies* **25**(12), 3610–3644.

Cheng, I.-H., Hong, H. and Scheinkman, J. A.: 2015, Yesterday's heroes: Compensation and risk at financial firms, *The Journal of Finance* **70**(2), 839–879.

Coles, J. L., Daniel, N. D. and Naveen, L.: 2006, Managerial incentives and risk-taking, *Journal of Financial Economics* **79**(2), 431–468.

Cong, L. W., Gao, H., Ponticelli, J. and Yang, X.: 2019, Credit allocation under economic stimulus: Evidence from China, *The Review of Financial Studies* **32**(9), 3412–3460.

Conyon, M. J. and He, L.: 2011, Executive compensation and corporate governance in China, *Journal of Corporate Finance* **17**(4), 1158–1175.

Conyon, M. J. and He, L.: 2016, Executive compensation and corporate fraud in China, *Journal of Business Ethics* **134**(4), 669–691.

Conyon, M. J. and Murphy, K. J.: 2000, The prince and the pauper? CEO pay in the United States and United Kingdom, *The Economic Journal* **110**(467), 640–671.

Core, J. E. and Guay, W. R.: 2002, The other side of the trade-off: The impact of risk on executive compensation: A revised comment, *Available at SSRN 292955* .

Coughlan, A. T. and Schmidt, R. M.: 1985, Executive compensation, management turnover, and firm performance: An empirical investigation, *Journal of Accounting and Economics* **7**(1-3), 43–66.

D'Acunto, F. and Rossi, A.: 2017, Regressive mortgage credit redistribution in the post-crisis era.

Dahiya, S., Ge, L. and Gete, P.: 2018, A model of managerial ownership, firm leverage and credit stimulus.

Dahiya, S., Iannotta, G. and Navone, M.: 2017, Firm opacity lies in the eye of the beholder, *Financial Management* **46**(3), 553–592.

Dee, C. C., Lulseged, A. and Nowlin, T. S.: 2005, Executive compensation and risk: The case of internet firms, *Journal of Corporate Finance* **12**(1), 80–96.

Dell'Ariccia, G., Laeven, L. and Suarez, G. A.: 2017, Bank leverage and monetary policy's risk-taking channel: Evidence from the United States, *The Journal of Finance* **72**(2), 613–654.

Deng, Y., Morck, R., Wu, J. and Yeung, B.: 2015, China's pseudo-monetary policy, *Review of Finance* **19**(1), 55–93.

Dittmann, I., Maug, E. and Spalt, O.: 2010, Sticks or carrots? Optimal CEO compensation when managers are loss averse, *The Journal of Finance* **65**(6), 2015–2050.

Dittmann, I., Yu, K.-C. and Zhang, D.: 2017, How important are risk-taking incentives in executive compensation?, *Review of Finance* **21**(5), 1805–1846.

Edmans, A. and Gabaix, X.: 2016, Executive compensation: A modern primer, *Journal of Economic Literature* **54**(4), 1232–1287.

Fama, E. F.: 1980, Agency problems and the theory of the firm, *Journal of Political Economy* **88**(2), 288–307.

Ferris, S. P., Hanousek, J., Shamshur, A. and Tresl, J.: 2018, Asymmetries in the firm's use of debt to changing market values, *Journal of Corporate Finance* **48**, 542–555.

Finkelstein, S. and Hambrick, D. C.: 1989, Chief executive compensation: A study of the intersection of markets and political processes, *Strategic Management Journal* **10**(2), 121–134.

Firth, M., Fung, P. M. and Rui, O. M.: 2006, Corporate performance and CEO compensation in China, *Journal of Corporate Finance* **12**(4), 693–714.

Firth, M., Lin, C. and Wong, S. M.: 2008, Leverage and investment under a state-owned bank lending environment: Evidence from China, *Journal of Corporate Finance* **14**(5), 642–653.

Fredrickson, J. W., Hambrick, D. C. and Baumrin, S.: 1988, A model of CEO dismissal, *Academy of Management Review* **13**(2), 255–270.

Gambacorta, L. and Marques-Ibanez, D.: 2011, The bank lending channel: lessons from the crisis, *Economic Policy* **26**(66), 135–182.

Gambacorta, L. and Shin, H. S.: 2016, Why bank capital matters for monetary policy, *Journal of Financial Intermediation* .

Garcia-Lorenzo, M. L., Villasur, J. G., Lamas, M. and Perez-Quiros, G.: 2021, Environmental destruction and housing prices: The case of Mar Menor in Spain.

Garvey, G. T. and Hanka, G.: 1999, Capital structure and corporate control: The effect of antitakeover statutes on firm leverage, *The Journal of Finance* **54**(2), 519–546.

Gayle, G.-L., Golan, L. and Miller, R. A.: 2015, Promotion, turnover, and compensation in the executive labor market, *Econometrica* **83**(6), 2293–2369.

Gete, P. and Gómez, J.-P.: 2015, Compensation contracts and fire sales, *Journal of Financial Stability* **18**, 154–171.

Gete, P. and Gómez, J.-P.: 2017, Dealing with overleverage: Restricting leverage vs. restricting variable compensation, *Quarterly Journal of Finance* p. 1850001.

Gete, P. and Gómez, J.-P.: 2018, Dealing with overleverage: Restricting leverage vs. restricting variable compensation, *Quarterly Journal of Finance* **8**(01), 1850001.

Gete, P. and Melkadze, G.: 2018a, Aggregate volatility and international dynamics. The role of credit supply, *Journal of International Economics* **111**, 143–158.

Gete, P. and Melkadze, G.: 2018b, A quantitative model of international lending of last resort.

Giannetti, M., Liao, G. and Yu, X.: 2015, The brain gain of corporate boards: Evidence from China, *The Journal of Finance* **70**(4), 1629–1682.

Giglio, S., Kelly, B. and Stroebel, J.: 2021, Climate finance.

Gilchrist, S., Sim, J. W. and Zakrajšek, E.: 2014, Uncertainty, financial frictions, and investment dynamics, *Technical report*, National Bureau of Economic Research.

Glover, B. and Levine, O.: 2015, Uncertainty, investment, and managerial incentives, *Journal of Monetary Economics* **69**, 121–137.

Golan, L., Parlour, C. A. and Rajan, U.: 2015, Competition, managerial slack, and corporate governance, *Review of Corporate Finance Studies* **4**(1), 43–68.

Gopalan, R., Milbourn, T., Song, F. and Thakor, A. V.: 2014, Duration of executive compensation, *The Journal of Finance* **69**(6), 2777–2817.

Gorry, A., Hassett, K. A., Hubbard, R. G. and Mathur, A.: 2017, The response of deferred executive compensation to changes in tax rates, *Journal of Public Economics* **151**, 28–40.

Grossman, S. J. and Hart, O. D.: 1992, An analysis of the principal-agent problem, *Foundations of insurance economics*, Springer, pp. 302–340.

Hall, B. J. and Murphy, K. J.: 2000, Optimal exercise prices for executive stock options, *The American Economic Review* **90**(2), 209–209.

He, Z.: 2011, A model of dynamic compensation and capital structure, *Journal of Financial Economics* **100**(2), 351–366.

Herman, E. S. et al.: 1981, *Corporate control, corporate power*, Vol. 98, Cambridge University Press New York.

Hill, C. W. and Phan, P.: 1991, CEO tenure as a determinant of CEO pay, *Academy of Management Journal* **34**(3), 707–717.

Huang, G. and Song, F.: 2006, The determinants of capital structure: Evidence from China, *China Economic Review* **17**(1), 14–36.

Ilhan, E.: 2021, Sea level rise and portfolio choice.

Ioannidou, V., Ongena, S. and Peydró, J.-L.: 2015, Monetary policy, risk-taking, and pricing: Evidence from a quasi-natural experiment, *Review of Finance* **19**(1), 95–144.

Ittner, C. D. and Larcker, D. F.: 2001, Assessing empirical research in managerial accounting: A value-based management perspective, *Journal of Accounting and Economics* **32**(1-3), 349–410.

Jaggia, P. B. and Thakor, A. V.: 1994, Firm-specific human capital and optimal capital structure, *International Economic Review* **35**(2), 283–308.

Jensen, M. C.: 1986, Agency costs of free cash flow, corporate finance, and takeovers, *The American Economic Review* **76**(2), 323–329.

Jensen, M. C. et al.: 1988, The takeover controversy: Analysis and evidence, *Knights, raiders and targets: The impact of the hostile takeover* pp. 314–54.

Jeske, K., Krueger, D. and Mitman, K.: 2013, Housing, mortgage bailout guarantees and the macro economy, *Journal of Monetary Economics* **60**(8), 917–935.

Jiang, F. and Kim, K. A.: 2015, Corporate governance in China: A modern perspective, *Journal* *of Corporate Finance* **32**, 190–216.

Jin, L.: 2002, CEO compensation, diversification, and incentives, *Journal of Financial Economics* **66**(1), 29–63.

John, T. A. and John, K.: 1993, Top-management compensation and capital structure, *The Journal of Finance* **48**(3), 949–974.

Kato, H. K., Lemmon, M., Luo, M. and Schallheim, J.: 2005, An empirical examination of the costs and benefits of executive stock options: Evidence from Japan, *Journal of Financial Economics* **78**(2), 435–461.

Keys, B. J. and Mulder, P.: 2020, Neglected no more: Housing markets, mortgage lending, and sea level rise, *National Bureau of Economic Research* (No. w27930).

Kolm, J., Laux, C. and Loranth, G.: 2016, Regulating bank CEO compensation and active boards, *Forthcoming in The Review of Finance* .

Lemmon, M. L., Roberts, M. R. and Zender, J. F.: 2008, Back to the beginning: persistence and the cross-section of corporate capital structure, *The Journal of Finance* **63**(4), 1575–1608.

Lewellen, K.: 2006, Financing decisions when managers are risk averse, *Journal of Financial Economics* **82**(3), 551–589.

Lewellen, W., Loderer, C. and Martin, K.: 1987, Executive compensation and executive incentive problems: An empirical analysis, *Journal of Accounting and Economics* **9**(3), 287–310.

Li, K., Yue, H. and Zhao, L.: 2009, Ownership, institutions, and capital structure: Evidence from China, *Journal of Comparative Economics* **37**(3), 471–490.

Liao, L., Liu, B. and Wang, H.: 2014, China's secondary privatization: Perspectives from the split-share structure reform, *Journal of Financial Economics* **113**(3), 500–518.

Liu, J., Nissim, D. and Thomas, J.: 2002, Equity valuation using multiples, *Journal of Accounting Research* **40**(1), 135–172.

Malmendier, U., Tate, G. and Yan, J.: 2011, Overconfidence and early-life experiences: the effect of managerial traits on corporate financial policies, *The Journal of Finance* **66**(5), 1687–1733.

McConnell, M. M. and Perez-Quiros, G.: 2000, Output fluctuations in the United States: What has changed since the early 1980's?, *American Economic Review* **90**(5), 1464–1476.

Mehran, H.: 1992, Executive incentive plans, corporate control, and capital structure, *Journal of Financial and Quantitative analysis* **27**(4), 539–560.

Michaely, R. and Roberts, M. R.: 2012, Corporate dividend policies: Lessons from private firms, *The Review of Financial Studies* **25**(3), 711–746.

Milidonis, A. and Stathopoulos, K.: 2014, Managerial incentives, risk aversion, and debt, *Journal of Financial and Quantitative Analysis* **49**(02), 453–481.

Miller, J. S., Wiseman, R. M. and Gomez-Mejia, L. R.: 2002, The fit between CEO compensation design and firm risk, *Academy of Management Journal* **45**(4), 745–756.

Morellec, E., Nikolov, B. and Schürhoff, N.: 2012, Corporate governance and capital structure dynamics, *The Journal of Finance* **67**(3), 803–848.

Murfin, J. and Spiegel, M.: 2020, Is the risk of sea level rise capitalized in residential real estate?, *The Review of Financial Studies* **33**(3), 1217–1255.

Naughton, B.: 2009, Understanding the Chinese stimulus package, *China Leadership Monitor* **28**(2), 1–12.

Ortega, F. and Taspinar, S.: 2018, Rising sea levels and sinking property values: Hurricane Sandy and New York's housing market, *Journal of Urban Economics* **106**, 81–100.

Ouyang, M. and Peng, Y.: 2015, The treatment-effect estimation: A case study of the 2008 economic stimulus package of China, *Journal of Econometrics* **188**(2), 545–557.

Panousi, V. and Papanikolaou, D.: 2012, Investment, idiosyncratic risk, and ownership, *The Journal of Finance* **67**(3), 1113–1148.

Piotroski, J. D. and Zhang, T.: 2014, Politicians and the IPO decision: The impact of impending political promotions on IPO activity in China, *Journal of Financial Economics* **111**(1), 111–136.

Pittman, J. A. and Fortin, S.: 2004, Auditor choice and the cost of debt capital for newly public firms, *Journal of Accounting and Economics* **37**(1), 113–136.

Prendergast, C.: 2000, What trade-off of risk and incentives?, *American Economic Review* **90**(2), 421–425.

Purda, L. D.: 2007, Stock market reaction to anticipated versus surprise rating changes, *Journal of Financial Research* **30**(2), 301–320.

Rambachan, A. and Roth, J.: 2019, An honest approach to parallel trends.

Rosenbaum, P. R. and Rubin, D. B.: 1983, The central role of the propensity score in observational studies for causal effects, *Biometrika* **70**(1), 41–55.

Sáez, C. C. M.: 2020, Socio-economic impact of Mar Menor harmful algal bloom in 2015-2016.

Schmitt-Grohé, S. and Uribe, M.: 2012, What's news in business cycles, *Econometrica* **80**(6), 2733–2764.

Shue, K. and Townsend, R. R.: 2017, How do quasi-random option grants affect CEO risk-taking?, *The Journal of Finance* **72**(6), 2551–2588.

Singh, H. and Harianto, F.: 1989, Management-board relationships, takeover risk, and the adoption of golden parachutes, *Academy of Management journal* **32**(1), 7–24.

Smith, D. R.: 2008, Testing for structural breaks in GARCH models, *Applied Financial Economics* **18**(10), 845–862.

Stock, J. H. and Watson, M. W.: 2012, Disentangling the channels of the 2007-2009 recession, *Technical report*, National Bureau of Economic Research.

Stroebel, J. and Wurgler, J.: 2021, What do you think about climate finance?, *Journal of Financial Economics* **142**(2), 487–498.

Vance, S. C.: 1983, *Corporate leadership: Boards, directors, and strategy*, McGraw-Hill New York.

Welch, I.: 2004, Capital structure and stock returns, *Journal of Political Economy* **112**(1), 106–131.