

ESSAYS IN HOUSING FINANCE

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Abstract

This thesis examines the role of investors in the housing and mortgage markets in the years following the Global Financial Crisis of 2007-2009. **Chapter 1** studies the effects of a new class of investors on the dynamics of housing affordability, post-crisis. Processing 85 million housing transactions and using a novel instrumental variable, I find that investors' presence increases the price-to-income ratio, especially in the lowest price-tier. Investors cause a medium-run positive response of construction and a short-run reduction in vacancies. These equilibrium effects mitigate the impact on affordability. In highly inelastic areas investors affect prices more than rents, whereas in highly elastic areas investors have the opposite effect.

Chapter 2 studies how investors in housing markets changed post-crisis and the consequences for markets and the economy. I document several new facts: Institutional investors have replaced individual investors, but small size investors dominate among these new investors. Most new investors are less likely to sell the properties in the short-term in response to capital gains. Their investment portfolio has a strong local bias and is driven by search for yield. The arrival of buy-and-hold investors is related to substantially lower price momentum. It is also related to reduced housing stock and time on the market for houses.

Chapter 3 studies how institutional investors in mortgage markets would absorb mortgage credit risk. The identification exploits Hurricanes Harvey and Irma and the Credit Risk Transfers (CRT) issued by the GSEs. CRTs are structured securities to transfer some of their credit risk to private investors. CRTs differ in the geographical and loan-to-value composition of their reference pool. These heterogeneities generate differences in exposure to hurricane-affected areas and to expectations of mortgage defaults. I find significant increases in the price of credit risk right after the hurricanes' landfall. I use these results to estimate a model of credit risk and evaluate how mortgage markets without government guarantees of the GSEs would fare over the housing boom-bust cycle.

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General Introduction

This thesis examines the role of institutional investors in the housing and mortgage markets in the years following the global financial crisis (GFC) of 2007-2009. First, it studies the effects of a new class of investors that entered local housing markets in the United States after 2009. These investors accounted for 12.37% of the annual housing purchases in the U.S. Metropolitan Statistical Areas (MSAs) over the period 2009 to 2017. The variation in the flow of investors in the cross-section of MSAs explains up to 82.7% of the variation in the median house prices, leading to worsening affordability. In the long-term the effects on affordability are mitigated by the response of construction.

Second, this thesis compares the new investors with the speculators that were partly responsible for the housing bubble of mid-2000s. It undertakes a comprehensive data exercise to classify all housing buyers in the U.S. from 2000 to 2017 into homeowners, institutional investors, individual investors or intermediaries, and shows new facts about how the investors evolved over the years: the institutional investors replaced the individuals, small investors and the largest ones in terms of value of total holdings increased the most, and the majority of investors purchased within their MSA. Regarding their investment strategy, this thesis shows that the new investors are 12% less likely to sell a house within two years, compared to the pre-GFC investors, for the same capital gains. This longer investment horizon is less likely to lead to a bust in the housing market cycle.

Finally, the thesis assesses the effects of investors in a newly formed market for mortgage credit risk. It shows evidence that this market is likely to mitigate the effects of a new crisis, if this were to happen. Furthermore, it shows the significant change in the pricing of credit risk in mortgage markets based on the investors' expectations of risk, compared to the pricing pre-GFC when government guarantees were in place. Overall, this thesis aims to understand important new developments in the housing and mortgage markets related to the presence of institutional investors. Understanding the effects of investors may inform new insights for positive steps forward to prevent a crisis of such large scale as the GFC.

Background

The housing and mortgage markets played a key role in triggering the GFC, and moved to the forefront of economic research and policy debates. A long period of economic boom from the 1990s, until the mid-2000 had housing prices rising in many developed countries in the world.

For example, in the United States from 1996 to 2006 real housing prices rose 128%.¹

At the same time there was a steady rise in household debt. From 1996 to 2006 the total household debt balance increased by 160%, with mortgage debt making up to 88% of total debt outstanding for homeowners.² The housing bubble in the United States reached a peak in housing prices in early 2006, and burst at the end of 2006. By mid-2009 real housing prices had fallen by 37% from their peak.³ The sharp fall of housing prices led homeowners to default on their mortgages. An unprecedented rate of foreclosures, up to 1.5% foreclosure starts,⁴ lead to a drop in the homeownership rate, that is, the share of households that owned their main residence.

There is ample research that studies the housing boom-bust cycle and the causes of the GFC (see for example Adelino, Schoar, and Severino 2016; Garriga and Hedlund 2020; Justiniano, Primiceri, and Tambalotti 2019; Mian and Sufi 2011; or Taltavull de La Paz et al. 2011). This thesis connects the previous literature with the study of a different housing boom that followed the GFC. It shows a novel fact that the participants in the new boom have a different investment strategy in terms of horizon. The participants driving this boom are less likely to cause a bust.

Around the years 2012-2013 housing prices in the U.S. and other advanced economies began to recover, and they kept increasing until this day. However, homeownership rates kept dropping, as evident from many countries such as the U.S., the U.K., Spain, Germany and Canada (Garriga, Gete, and Eubanks 2018). This stylized fact is specific to the period following the GFC. While historically, in many advanced economies, the cost of buying a house has been positively correlated with the percentage of households that own their home, this trend seemed to change after the GFC.

It is not clear whether the negative correlation between house prices and homeownership is a transitory or permanent change in secular trends. A variety of factors might have lead to this effect. Some of these factors are labor market instability that limits the ability to borrow, re-balancing the balance sheets that deteriorated during the GFC, restrictions to credit markets for those households that had defaulted in the past, demographic trends, and different taste for housing for the millennial generation (see for example, Acolin et al. 2016; Arundel and Doling 2017; Dotti Sani and Acciai 2018; Gabriel and Rosenthal 2015; Halket and di Custozza 2015;

¹Rise of 193% of the S&P/Case-Shiller 10-City Composite Home Price Index (SPCS10RSA) and rise of 29% of the Consumer Price Index. Source: FRED.

²Data from Mian and Sufi (2011).

³Fall of 33% of the S&P/Case-Shiller 10-City Composite Home Price Index (SPCS10RSA) and rise of 6% of the Consumer Price Index. Source: FRED.

⁴Data from Corbae and Quintin (2015).

Kemp 2015).

The above trends coincided with the rise of investors in housing markets that saw low house prices, high potential return from the increasing demand for tenant-occupied housing, and low returns on safe assets. The presence of institutional investors, that is, large or small legal entities, in the housing market in the aftermath of the GFC was unprecedented.

Questions

Recent literature has acknowledged the substantial flow of institutional investors in the housing markets (see for example, Allen et al. 2018; Ganduri, Xiao, and Xiao 2019; Mills, Molloy, and Zarutskie 2019; Raymond et al. 2018; Taltavull de La Paz, López, and Juárez 2017). The literature acknowledges that with the housing prices rising and households being crowded out of the market for ownership, more research is required to understand the causal effects of investors on the real economy. It is also critical to examine the effects of investors on housing affordability, a topic that has gathered a lot of interest in the literature, as well as policy debates around the world.

Housing affordability

Affordability is one of the most important issues for housing policy in many developed countries. The rise of housing costs prior to the global financial crisis in relation to the households' income, brought to light serious affordability issues, for example in the U.K. (Fingleton 2008; Hilber and Vermeulen 2010), Spain (Taltavull de La Paz 2007), Australia (Taltavull de La Paz and Worthington 2012; Yates 2008), Canada (Bunting, Walks, and Filion 2004; Moore and Skaburskis 2004) and the U.S. (Glaeser and Gyourko 2003; Somerville and Mayer 2003). At the peak of the U.S. housing bubble, the price of a median house was more than three times the median annual household income in 60% of the Metropolitan Statistical Areas.⁵

While the ratio of the house price to the household's income indicated a problem of housing affordability for the median household, homeownership was made possible through a combination of factors, including overblown collateral values and relaxed requirements for access to credit. However, this was not the case in the recovery from the GFC. Aspiring homeowners were left out of the market for ownership, while the institutional investors had several advantages in this market.

⁵See Figure 1.1.

Investors in housing markets

Several trends post-GFC created favorable conditions for institutional investors to enter the housing market with main strategy to buy-and-rent. First, the large housing stock for sale made it possible to create geographically concentrated pools of similar properties (Mills, Molloy, and Zarutskie 2019). Second, tight mortgage lending to households increased demand for rental units (Gete and Reher 2018). Third, strict mortgage lending requirements gave an advantage to large investors to finance purchases (including borrowing at low rates, securitizing the rental flows or making all cash-purchases) relative to households (Allen et al. 2018). Fourth, technological developments made it possible to sell and manage large numbers of properties, and enjoy operational and cost efficiencies (Allen et al. 2018).

The literature has paid a lot of attention to the housing investors during the housing boom that preceded the GFC. While there is not full consensus about the mechanisms that caused the housing boom and bust, there is consensus that investors speculated about even larger than the ongoing price growth and bought several properties with the intention to sell in search for capital gains (see for example Chinco and Mayer 2015; or Gao, Sockin and Xiong 2020). The experience of the GFC has highlighted the importance of understanding the investment strategy and the influence investors have on housing market indicators, such as liquidity and price momentum. Besides documenting that the new post-GFC investors are institutional, and have better financing opportunities than households, the literature has left unanswered questions about the investment strategy of the new investors and its implications on liquidity and price momentum.

Investors in mortgage markets

The GFC brought into the spotlight the U.S. mortgage market. Following the alarming mortgage default rates, the Government Sponsored Enterprises (GSE), Fannie Mae and Freddie Mac, who were guaranteeing mortgage payments for loans securitized in mortgage backed securities, became financially distressed.⁶ Over the year from June 2007 to June 2008 Fannie Mae and Freddie Mac together posted \$14.2 billion in losses, while their combined capital amounted to only about 1% of their exposure to mortgage risk (Frame et al. 2015). This led to the imposition of federal conservatorship to Fannie Mae and Freddie Mac under the Federal Housing Finance Agency (FHFA). At the start of their conservatorship, the GSEs held or guaranteed about \$5.2 trillion of home mortgage debt, that in effect became liability of the U.S. taxpayers.

⁶The collapse of mortgage backed security values and the bailout of investment banks is out of the scope of this thesis.

At the heart of the housing reform efforts is the future of the GSEs.

One of the most important reforms was the introduction of a new market for credit risk in 2013. Investors in this market would take part in sharing the downside risk in the mortgage market. In other words, investors would purchase rights to cashflows from mortgage payments, and would suffer losses when these payment fail. This arrangement transfers part of the credit risk from the GSEs and taxpayers to a market participating institutional investors.

This new market for mortgage credit risk, while still at the beginning, has demonstrated liquidity and effectiveness in absorbing credit risk (Finkelstein, Strzodka, and Vickery 2018; Wachter Forthcoming). However, only very recently it has been stressed when two of the most catastrophic hurricanes in the Atlantic, Hurricanes Harvey and Irma, caused major disasters to homes in U.S. coasts in 2017. It is critical to study how would this market fare in a period of market stress. In a broader picture, how would the mortgage market fare in a period of market stress when the GSE guarantees are removed.

Objectives and Methodology

This thesis assesses the role and the implications of institutional investors in the post GFC housing boom. More specifically, each of the three chapters is dedicated to addressing a specific aspect of their presence. The methodology of each chapter is selected with the goal to be consistent with the chapter's objective. Thus, this thesis utilizes a variety of different methods and datasets, as I describe below.

Chapter 1 examines the causal effects of institutional investors in the housing markets on the real economy, focusing on the short-term and long-term effects on affordability. The objective is to quantify the causal effects of investors on housing affordability post-GFC. This is an empirical question. To address this question, I utilize a rich dataset from all the Metropolitan Statistical Areas (MSAs) of the United States. The MSA housing markets were hit by the GFC, some more severely than others. Importantly, the MSAs are subject to uniform federal regulations that could affect housing markets, and at the same time have variations in the flow of purchases by investors, which is necessary to identify the effect. Alternative datasets could have been appropriate, such as areas in the U.K. or Spain. However, I found greater data availability for the U.S., and specifically detailed microdata of housing transactions that I use to classify the purchases for example by institutional investors or homeowners.

Since the focus is on causality, I estimate a regression model of housing affordability on the share of investors' purchases in the market, by employing an instrumental variable for the share

of investors. Moreover, to estimate the effects in the long-term, I follow the methodology of Jordà (2005) that estimates local projections at each period of interest.

Chapter 2 investigates in more detail the investment strategy of the new institutional investors post-GFC, in terms of the holding period and sensitivity to capital gains. The objective is to understand the prevailing strategy by institutional investors and its implications on liquidity and price momentum in the housing markets. Moreover, this chapter compares the investment strategy of the new institutional investors with the frequent strategy of the investors during the housing boom that preceded the GFC. The large data availability at transaction level for the pre- and post-GFC periods, and the prevalence of housing investors led me to select the U.S. housing market as the setting of this study. Similar to the previous chapter, other advanced economies would be appropriate to implement this study.

The empirical methodology consists of several parts. First, I present detailed descriptives of the presence of investors in the U.S. housing market, such as the flow of purchases from 2000 to 2017, and the distribution by size pre- and post-crisis. Second, I use hedonic regression to estimate prices of the houses purchased by investors and the capital gains that would be realized if these were sold in the short-term. Third, I use logistic regressions at property level, to estimate the probability of following a short-term strategy (selling within two years) based on investors' characteristics. Forth, I use regression analyses at the MSA level to estimate the associations between the flow of purchases by investors and time-on-the market or price momentum. I compare the association of investors and price momentum post-GFC to the association pre-GFC.

Chapter 3 examines the increasing involvement of institutional investors in the market for mortgage credit risk and develops a counterfactual scenario where mortgage markets functioned without credit risk guarantees during the previous housing cycle. The objective is to estimate the investors' pricing of credit risk, based on actual experience in the credit risk market. Based on this estimation, the second objective is to calibrate a model that would simulate a mortgage market where the rates react to the perceived credit risk. The U.S. setting is ideal for this study, due to mortgage market characteristics: first, a newly introduced market for credit risk, and second, dramatic policy interest on the consequences of the removal of credit guarantees on the most common mortgages. This study would apply to other economies with liquid markets for mortgage securitization and credit risk guarantees. To achieve these objectives, I utilize market data from a large credit risk transfer program in the U.S.

In the first part of this chapter, I use a difference-in-difference estimation, to quantify the market reaction to increased expectations of mortgage defaults. Difference-in-difference

resembles an experimental methodology where a treatment and control groups are compared based to their reaction to treatment. In this study, the treatment is a shock that increases expectations of credit losses, specifically large catastrophic hurricanes. The treatment group consists of the prices of securities with large exposure to the hurricane-destroyed areas, and the control group are the prices of securities with small exposure to these areas. In the second part I use the previous estimations to calibrate and solve a credit risk model. The model is based on the lenders' mortgage pricing. I then simulate the experience of mortgage defaults during the previous housing cycle to derive the counterfactual pricing in the mortgage market, in the absence of guarantees.

Introducción General

Esta tesis examina el papel de los inversores institucionales en los mercados de vivienda e hipotecas en los años posteriores a la crisis financiera mundial (CFM) de 2007-2009. Primero, estudia los efectos de una nueva clase de inversores que ingresaron en los mercados inmobiliarios locales en Estados Unidos después de 2009. Estos inversores representaron el 12,37% de las compras anuales de viviendas en las áreas estadísticas metropolitanas de los Estados Unidos (MSA) durante el período 2009 a 2017. La variación en el flujo de inversores en la sección transversal de las MSAs explica hasta el 82,7% de la variación en los precios medios de la vivienda, lo que lleva a un empeoramiento de la asequibilidad.

Segundo, esta tesis compara a los nuevos inversores con los especuladores que fueron en parte responsables de la burbuja inmobiliaria de mediados de la década del 2000. Lleva a cabo un exhaustivo análisis de datos para clasificar a todos los compradores de vivienda en los EE. UU. entre 2000 y 2017 en distintas categorías: propietarios, inversores institucionales, inversores individuales o intermediarios. También muestra nuevos resultados empíricos sobre cómo evolucionaron los inversores a lo largo de los años: los inversores institucionales reemplazaron a los inversores individuales, los inversores más grandes aumentaron más su peso relativo en las inversiones, y la mayoría de los inversores compraron dentro de su MSA. En cuanto a su estrategia de inversión, esta tesis muestra que para las mismas ganancias de capital los nuevos inversores tienen un 12% menos de probabilidad de vender una casa en dos años, en comparación con los inversores anteriores a la CFM. Es menos probable que este horizonte de inversión más largo amplifique las caídas en el ciclo del mercado de la vivienda.

Por último, la tesis evalúa los efectos de los inversores en un mercado recién formado para el riesgo de crédito hipotecario. Muestra evidencia de que es probable que este mercado mitigue los efectos de una nueva crisis, si esto sucediera. Además, muestra el cambio significativo en la fijación de precios del riesgo de crédito en los mercados hipotecarios en función de las expectativas de riesgo de los inversores, en comparación con la fijación de precios antes de la CFM cuando existían garantías gubernamentales. En general, esta tesis tiene como objetivo comprender las importantes novedades en los mercados de vivienda e hipotecas relacionadas con la presencia de inversores institucionales. Comprender los efectos de los inversores puede aportar nuevos conocimientos para dar pasos positivos para prevenir una crisis de tan gran escala como la CFM.

Antecedentes

Los mercados de vivienda e hipotecas desempeñaron un papel clave en el desencadenamiento de la CFM y pasaron a la vanguardia de la investigación económica y los debates políticos. Durante un largo período de auge económico desde la década de 1990 hasta mediados de 2000, los precios de la vivienda aumentaron en muchos países desarrollados del mundo. Por ejemplo, en Estados Unidos de 1996 a 2006 los precios reales de la vivienda aumentaron un 128%.

Al mismo tiempo, se produjo un aumento constante de la deuda de los hogares. De 1996 a 2006 el saldo total de la deuda de los hogares aumentó en un 160%, y la deuda hipotecaria representó hasta el 88% de la deuda total pendiente de los propietarios. La burbuja inmobiliaria en Estados Unidos alcanzó un pico en los precios de la vivienda a principios de 2006 y estalló a finales de 2006. A mediados de 2009 los precios reales de la vivienda habían caído un 37% desde su pico. La fuerte caída de los precios de la vivienda llevó a los propietarios a incumplir con sus hipotecas. Una tasa sin precedentes de ejecuciones hipotecarias, hasta un 1,5% de inicio de ejecuciones hipotecarias, conduce a una caída en la tasa de propiedad de vivienda, es decir, la proporción de hogares que eran propietarios de su residencia principal.

Existe una amplia línea de investigación que estudia el ciclo de subidas y caídas de los precios de la vivienda y las causas de la CFM (ver, por ejemplo, Adelino, Schoar y Severino 2016; Garriga y Hedlund 2020; Justiniano, Primiceri y Tambalotti 2019; Mian y Sufi 2011; o Taltavull de La Paz y col. 2011). Esta tesis conecta la literatura anterior con el estudio de un boom inmobiliario diferente que siguió a la CFM. Muestra un hecho novedoso: los participantes en el nuevo boom tienen una estrategia de inversión diferente en términos de horizonte. Los participantes que impulsan este boom tienen menos probabilidades de provocar una quiebra.

Alrededor de los años 2012-2013, los precios de la vivienda en EE. UU. y otras economías avanzadas comenzaron a recuperarse y empezaron una tendencia alcista. Sin embargo, los porcentajes de vivienda en propiedad siguieron cayendo en muchos países como EE. UU., Reino Unido, España, Alemania y Canadá (Garriga, Gete y Eubanks 2018). Este hecho novedoso es específico del período posterior a la CFM pues históricamente, el precio de la vivienda estaba positivamente correlacionado con el porcentaje de hogares que poseen su propia casa, lo que ahora ha cambiado pasando incluso a ser correlación negativa.

No está claro si la correlación negativa entre los precios de la vivienda y la propiedad de la vivienda es un cambio transitorio o permanente en las tendencias seculares. Varios factores pueden haber provocado este efecto. Algunos de estos factores son la inestabilidad del mercado laboral que limita la capacidad de endeudamiento, el reequilibrio de los balances de los hogares que se deterioraron durante la CFM, las restricciones a los mercados crediticios para aquellos

hogares que habían incumplido en el pasado, las tendencias demográficas y el diferente gusto por la vivienda de la generación millennial (ver, por ejemplo, Acolin y col. 2016; Arundel y Doling 2017; Dotti Sani y Acciai 2018; Gabriel y Rosenthal 2015; Halket y di Custoza 2015; Kemp 2015).

Las tendencias anteriores coincidieron con el aumento de los inversores en los mercados de la vivienda. Estos inversores fueron atraídos por bajos precios de la vivienda, un alto rendimiento potencial de la creciente demanda de viviendas ocupadas por inquilinos y bajos rendimientos sobre activos seguros. La presencia de inversores institucionales, es decir, entidades legales grandes o pequeñas, en el mercado de la vivienda después de la CFM es especialmente novedosa.

Cuestiones

La literatura reciente ha reconocido el flujo sustancial de inversores institucionales en los mercados de la vivienda (ver, por ejemplo, Allen y col. 2018; Ganduri, Xiao y Xiao 2019; Mills, Molloy y Zarutskie 2019; Raymond y col. 2018; Taltavull de La Paz, López y Juárez 2017). La literatura reconoce que con el aumento de los precios de la vivienda y la expulsión de los hogares del mercado de la propiedad, se requiere más investigación para comprender los efectos causales de los inversores en la economía real. También es fundamental examinar los efectos de los inversores en la asequibilidad de la vivienda, un tema que ha despertado mucho interés en la literatura, así como en los debates sobre políticas en todo el mundo.

La asequibilidad de la vivienda

La asequibilidad es uno de los temas más importantes para la política de vivienda en muchos países desarrollados. El aumento de los costes de la vivienda antes de la crisis financiera mundial en relación con los ingresos de los hogares sacó a la luz serios problemas de asequibilidad, por ejemplo en el Reino Unido (Fingleton 2008; Hilber y Vermeulen 2010), España (Taltavull de La Paz 2007), Australia (Taltavull de La Paz y Worthington 2012; Yates 2008), Canadá (Bunting, Walks y Filion 2004; Moore y Skaburskis 2004) y Estados Unidos (Glaeser y Gyourko 2003; Somerville y Mayer 2003). En el pico de la burbuja inmobiliaria de Estados Unidos el precio de una casa promedio era más de tres veces el ingreso familiar anual promedio en el 60% de las áreas estadísticas metropolitanas.

Si bien la relación entre el precio de la vivienda y los ingresos del hogar indicaba un problema de asequibilidad de la vivienda para el hogar medio, la propiedad de la vivienda fue posible gracias a una combinación de factores, incluidos los valores de las garantías exageradas y los

relajados requisitos para el acceso al crédito. Sin embargo, este no fue el caso en la recuperación de la CFM. Los aspirantes a propietarios quedaron fuera del mercado de la propiedad, mientras que los inversores institucionales tenían varias ventajas en este mercado.

Inversores en mercados de las viviendas

Varias tendencias posteriores a la CFM crearon condiciones favorables para que los inversores institucionales ingresaran en el mercado de la vivienda con una estrategia principal de compra y alquiler. En primer lugar, el gran stock de viviendas a la venta hizo posible la creación de conjuntos concentrados geográficamente de propiedades similares (Mills, Molloy y Zarutskie 2019). En segundo lugar, los préstamos hipotecarios ajustados a los hogares aumentaron la demanda de unidades de alquiler (Gete y Reher 2018). En tercer lugar, los estrictos requisitos de préstamos hipotecarios dieron una ventaja a los grandes inversores para financiar las compras (incluidos los préstamos a tasas bajas, la titulización de los flujos de alquiler o la realización de todas las compras en efectivo) en relación con los hogares (Allen y col. 2018). Cuarto, los desarrollos tecnológicos hicieron posible vender y administrar un gran número de propiedades y disfrutar de eficiencias operativas y de costes (Allen y col. 2018).

La literatura ha prestado mucha atención a los inversores inmobiliarios durante el boom inmobiliario que precedió a la CFM. Si bien no existe un consenso total sobre los mecanismos que causaron el auge y la caída de la vivienda, existe el consenso de que los inversores especularon sobre un crecimiento de precios aún mayor que el actual y compraron varias propiedades con la intención de vender en busca de ganancias de capital (ver, por ejemplo, Chincó y Mayer 2015; o Gao, Sockin y Xiong 2020). La experiencia de la CFM ha destacado la importancia de comprender la estrategia de inversión y la influencia que tienen los inversores en los indicadores del mercado de la vivienda, como la liquidez y el impulso de los precios. Además de documentar que los nuevos inversores post-CFM son institucionales y tienen mejores oportunidades de financiación que los hogares, la literatura ha dejado preguntas sin respuesta sobre la estrategia de inversión de los nuevos inversores y sus implicaciones sobre la liquidez y el impulso de los precios.

Inversores en mercados hipotecarios

La CFM llamó la atención sobre el mercado hipotecario estadounidense. Tras las alarmantes tasas de incumplimiento hipotecario, las Empresas Patrocinadas por el Gobierno (GSE), Fannie Mae y Freddie Mac, que estaban garantizando los pagos de hipotecas para préstamos tituliza-

dos en valores respaldados por hipotecas, sufrieron dificultades financieras. Durante el año comprendido entre junio de 2007 y junio de 2008, Fannie Mae y Freddie Mac juntos registraron pérdidas por valor de 14,2 millones de dólares, mientras que su capital combinado representó solo alrededor del 1% de su exposición al riesgo hipotecario (Frame y col. 2015). Esto llevó a la imposición de la tutela federal a Fannie Mae y Freddie Mac bajo la Agencia Federal de Financiamiento de la Vivienda (FHFA). Al comienzo de su tutela las GSE tenían o garantizaban alrededor de 5,2 billones de dólares de deuda hipotecaria, que de hecho se convirtió en responsabilidad de los contribuyentes estadounidenses. En el corazón de los esfuerzos de reforma de la vivienda está el futuro de las GSE.

Una de las reformas más importantes fue la introducción de un nuevo mercado de riesgo crediticio en 2013. Los inversores de este mercado participarían en la distribución del riesgo a la baja en el mercado hipotecario. En otras palabras, los inversores comprarían derechos sobre los flujos de caja de los pagos de la hipoteca y sufrirían pérdidas cuando estos pagos no se realizaran. Este arreglo transfiere parte del riesgo crediticio de las GSE y los contribuyentes a los inversores institucionales participantes del mercado.

Este nuevo mercado para el riesgo crediticio hipotecario, aunque todavía está en sus inicios, ha demostrado liquidez y eficacia en la absorción del riesgo crediticio (Finkelstein, Strzodka y Vickery 2018; Wachter Forthcoming). Sin embargo solo se ha enfatizado recientemente, cuando dos de los huracanes más catastróficos en el Atlántico, los huracanes Harvey e Irma, causaron grandes desastres en hogares de las costas de Estados Unidos en 2017. Es fundamental estudiar cómo le iría a este mercado en un período de estrés del mercado. En un panorama más amplio, ¿cómo le iría al mercado hipotecario en un período de tensión del mercado cuando se eliminan las garantías GSE?

Objetivos y Metodología

Esta tesis evalúa el papel y las implicaciones de los inversores institucionales en el boom inmobiliario posterior a la CFM. Más específicamente, cada uno de los tres capítulos está dedicado a abordar un aspecto específico de su presencia. La metodología de cada capítulo se selecciona con el objetivo de ser coherente con el objetivo del capítulo. Por lo tanto, esta tesis utiliza una variedad de métodos y conjuntos de datos diferentes, como describo a continuación.

El Capítulo 1 examina los efectos causales de los inversores institucionales en los mercados de la vivienda sobre la economía real, centrándose en los efectos a corto y largo plazo sobre la asequibilidad. El objetivo es cuantificar los efectos causales de los inversores sobre la

asequibilidad de la vivienda después de la CFM. Esta es una pregunta empírica. Para abordar esta pregunta utilizo un rico conjunto de datos de todas las áreas estadísticas metropolitanas (MSA) de Estados Unidos. Los mercados inmobiliarios de MSA se vieron afectados por la CFM, algunos más gravemente que otros. Es importante destacar que las MSAs están sujetas a regulaciones federales uniformes que podrían afectar a los mercados de vivienda y, al mismo tiempo, tienen variaciones en el flujo de compras por parte de los inversores, lo cual es necesario para identificar el efecto. Los conjuntos de datos alternativos podrían haber sido adecuados, como en áreas en el Reino Unido o España. Sin embargo, he encontrado una mayor disponibilidad de datos para Estados Unidos y microdatos específicamente detallados de transacciones de vivienda que utilizo para clasificar las compras, por ejemplo, de inversores institucionales o propietarios de viviendas.

Dado que el enfoque está en la causalidad, estimo un modelo de regresión de la asequibilidad de la vivienda sobre la participación de las compras de los inversores en el mercado, empleando una variable instrumental para la participación de los inversores. Además, para estimar los efectos a largo plazo, sigo la metodología de Jordà (2005) que estima proyecciones locales en cada período de interés.

El Capítulo 2 investiga con más detalle la estrategia de inversión de los nuevos inversores institucionales post-CFM, en términos del período de tenencia y sensibilidad a las ganancias de capital. El objetivo es comprender la estrategia imperante por parte de los inversores institucionales y sus implicaciones sobre la liquidez y el impulso de los precios en los mercados inmobiliarios. Además, este capítulo compara la estrategia de inversión de los nuevos inversores institucionales con la estrategia frecuente de los inversores durante el boom inmobiliario que precedió a la CFM. La gran disponibilidad de datos a nivel de transacción para los períodos anterior y posterior a la CFM y la prevalencia de los inversores inmobiliarios me llevaron a seleccionar el mercado inmobiliario estadounidense como escenario de este estudio. Al igual que en el capítulo anterior, otras economías avanzadas serían adecuadas para implementar este estudio.

La metodología empírica consta de varias partes. En primer lugar, presento descripciones detalladas de la presencia de inversores en el mercado inmobiliario de EE.UU., como el flujo de compras entre 2000 y 2017, y la distribución por tamaño antes y después de la crisis. En segundo lugar, utilizo la regresión hedónica para estimar los precios de las casas compradas por los inversores y las ganancias de capital que se obtendrían si se vendieran a corto plazo. En tercer lugar, utilizo regresiones logísticas a nivel de propiedad para estimar la probabilidad de seguir una estrategia a corto plazo (vender en dos años) en función de las características de los inversores. En cuarto lugar, utilizo análisis de regresión a nivel de MSA para estimar las

asociaciones entre el flujo de compras de los inversores y el tiempo en el mercado o el impulso de los precios. Comparo la asociación de inversores y el impulso de los precios después de CFM con la asociación anterior a CFM.

El Capítulo 3 examina la creciente participación de los inversores institucionales en el mercado de riesgo crediticio hipotecario y desarrolla una hipótesis de contraste en la que los mercados hipotecarios funcionaron sin garantías de riesgo crediticio durante el ciclo anterior de la vivienda. El objetivo es estimar el precio del riesgo crediticio por parte de los inversores, con base en la experiencia real en el mercado de riesgo crediticio. Con base en esta estimación, el segundo objetivo es calibrar un modelo que simule un mercado hipotecario donde las tasas reaccionan al riesgo crediticio percibido. El entorno estadounidense es ideal para este estudio debido a las características del mercado hipotecario: primero, un mercado recientemente introducido para el riesgo crediticio, y segundo, el interés dramático de las políticas sobre las consecuencias de la eliminación de las garantías crediticias en las hipotecas más comunes. Este estudio se aplicaría a otras economías con mercados líquidos para la titulización de hipotecas y garantías de riesgo crediticio. Para lograr estos objetivos, utilizo datos de mercado de un gran programa de transferencia de riesgo crediticio en Estados Unidos.

En la primera parte de este capítulo utilizo una estimación de diferencias en diferencias para cuantificar la reacción del mercado ante el aumento de las expectativas de incumplimiento de las hipotecas. La diferencia en la diferencia se asemeja a una metodología experimental en la que un grupo de tratamiento y un grupo de control se comparan en función de su reacción al tratamiento. En este estudio el tratamiento es un shock que aumenta las expectativas de pérdidas crediticias, específicamente grandes huracanes catastróficos. El grupo de tratamiento consiste en los precios de los valores con gran exposición a las áreas destruidas por el huracán, y el grupo de control son los precios de los valores con poca exposición a estas áreas. En la segunda parte utilizo las estimaciones anteriores para calibrar y resolver un modelo de riesgo crediticio. El modelo se basa en los precios de las hipotecas de los prestamistas. A continuación, simulo la experiencia de incumplimiento de las hipotecas durante el ciclo anterior de la vivienda para derivar el precio contrafactual en el mercado hipotecario, en ausencia de garantías.

Chapter 1

Investors in Housing Markets and Affordability

1.1 Introduction

Housing affordability is a critical challenge for most cities around the globe. In the United States, the median housing price in 55% of the Metropolitan Statistical Areas (MSAs) exceeded three times the annual income of the median household in 2019. Moreover, in the same year, in 42% of the MSAs the rent-to-income ratio surpassed the rental affordability threshold of 27%. As Figure 1.1 shows, the recent price-to-income and rent-to-income ratios resemble the lack of housing affordability during the large housing boom of the early 2000s.

This chapter explores the link of the recent worsening of housing affordability to a new class of investors that emerged in real estate markets, called institutional investors. In Urban Economics housing is viewed as a localized consumption good. This literature suggests that affordability problems are due to geographical areas with strict regulatory constraints in the production of this good (see for example Glaeser and Gyourko 2003, 2018; Molloy, Nathanson, and Paciorek 2020).

This chapter views housing from the perspective of Finance, as an asset/investment that provides services. The identity or nature of the buyers/investors can influence the asset valuation. In this regard this chapter contributes to a growing literature that focuses on investors in housing markets, such as, for example, Mills, Molloy, and Zarutskie (2019), Favilukis and Van Nieuwerburgh (2018) or Taltavull de La Paz, López, and Juárez (2017). This study connects these seemingly separated literatures. It is one of the first to provide evidence of causal effects of institutional investors on housing affordability post-crisis. It shows that the effects of investors' presence differs across price-tiers and areas with different supply restrictions.

Institutional investors are defined as legal entities who purchase two or more properties

within an MSA over two years under the name of an LP, Trust, LLC, REIT, etc. The explosive growth of institutional investors across U.S. housing markets after the Financial Crisis has been discussed in the popular press, such as *The Wall Street Journal* (2017), or the ACCE Institute Report (Abood 2018). Figure 1.2 shows a new fact: the MSAs that had the biggest market share of house purchases by institutional investors post-crisis also experienced the biggest increase in the price-to-income ratio. It is not straightforward to establish a causal connection. A standard OLS regression of house price growth on the institutional investors' market share would likely be downward biased if investors were attracted to locations where the house prices collapsed during and after the crisis. For this reason, I employ an instrumental variable approach with a rich panel dataset that covers all U.S. MSAs for the years 2000 to 2017.

The instrument takes advantage of the Quantitative Easing (QE) programs that the Fed implemented during the financial crisis. The QE resulted in a sharp decline in the returns of safe assets, which encouraged risk-taking behavior by investors. Several authors, such as Martínez-Miera and Repullo (2017), Rodnyansky and Darmouni (2017), Daniel, Garlappi, and Xiao (2018), and Campbell and Sigalov (2020) documented the search for yield triggered by low-interest-rate monetary policy. The QE was a national shock, however different regions reacted differently based on the existing propensity for investments among the local high-income population. High-earning, sophisticated, risk-seeking residents with high propensity to invest and/or understand investments direct more capital to the housing market, through new or existing legal entities. De Stefani (2020) documented the rise in the investment attitude towards housing of the wealthy population in the U.S. following the financial crisis. Thus, the instrument captures the local exposure to the QE that channels investment into the housing markets, measured by the share of the top earners' business income over total income in each MSA in 2007.

It is straightforward to show that this instrument is highly correlated with the geographical presence of institutional housing investors post-crisis, thus satisfies the relevance condition. Importantly, I perform several tests to rigorously assess the exclusion restriction that makes me confident that the identification is valid. That is, conditional on observables, the share of the top earners' business income is uncorrelated with factors that determine house prices: First, I provide extensive evidence that in the pre-QE period the instrument does not predict changes in housing prices or new construction. Areas with the highest or lowest levels of the instrument exhibit parallel pre-trends. Placebo tests confirm that the instrument only captures post-crisis shocks to investment in the housing markets. The assumption that there were no pre-existing differences in the growth of housing prices and that the common unconventional monetary policy shock caused the changes in price growth seems plausible (Goldsmith-Pinkham, Sorkin,

and Swift 2020).

Second, I provide evidence that it is very hard to predict the investment attitude of an MSA, as analogously it is difficult to explain which cities become hubs for entrepreneurship (Davidsson 1991; Rocha and Sternberg 2005; Bosma and Kelley 2019). For example when trying to predict cross-regional differences in entrepreneurship the largest R-squared in Davidsson (1991) is 25%, and in Rocha and Sternberg (2005) is 23%. That is, even if factors such as the tax regime, natural amenities, or the structure of the population have some forecasting power, most of the cross-sectional geographical variation in entrepreneurship, and in the share of business income, is unexplained. Moreover, since the instrument is determined prior to the period of study (2009 to 2017) this reduces risk of reverse causality.

Third, I run a number of specifications to show that the results are not driven by shifts in the composition of labor demand of MSAs during the post-crisis period. Fourth, I control thoroughly for an array of fixed effects and of local activity trends (income, population flows, unemployment, GDP, wages and labor force participation), so it is unlikely that the error term reflects common movers of both investors and housing market variables. Finally, I confirm the robustness of the results to alternative measures of the investors' presence and different geographical units.

The first result is that institutional investors increase house prices and worsen affordability. In the sample between the years 2009 to 2017, the average share of institutional investors' purchases is 12.37% with standard deviation 7.78%. I find that one standard deviation higher purchases leads to 1.46 percentage points higher house price growth for the median house. This equals 82.7% of the standard deviation of house price growth over the period. In addition, I find that prices increase faster than income. More investigation shows that these results do not come from the variation driven by the "superstar cities" as discussed by Gyourko, Mayer, and Sinai (2013), or by the purchases of "Wall Street Landlords" that often appear in the popular press. In a new analysis that excludes the cities that have the most "Wall Street Landlords", often correlated with the superstar cities, I arrive to the same conclusions.

I study the impact of investors' purchases separately across different price tiers, since housing markets are segmented and price growth varies systematically across different price tiers (see Piazzesi, Schneider, and Stroebel 2020, and Armesto and Garriga 2009). The results show that the effects are larger for the bottom price tier compared to the top one. In the bottom price tier, one standard deviation higher investors' purchases causes 2.29 percentage points higher house price growth. As first-time buyers usually purchase housing from the bottom price segment, it is apparent that the institutional investors had large negative effects on affordability especially

for this group.

It is relevant to separate the effects in the short-run where the housing supply is more inelastic from the effects in the long-run when housing supply can respond. To address this question, the second part of this chapter quantifies the dynamic effects of investors on housing affordability, and the supply response, using the local projection method from Jordà (2005). To construct the panel instrument, I interact the 2007 business income share for top earners and the growth rate in the rate on certificate of deposits (CDs). This is like the housing net worth channel of Mian and Sufi (2014) that exposes certain areas to larger macro effects from declines in housing prices due to their housing leverage. In this case, I expose investment-prone areas to the QE shock.

Over time, the dynamic effect of institutional investors' purchases changes. Much of the cross-sectional results are driven by a strong short-run response of price increases that weakens over time. In the long-run I find a significant response of housing supply, measured by the number of new construction permits. The dynamic analysis shows how the presence of institutional investors reduces the number of vacancies in the short-run, and generates a medium-run response of new construction. These equilibrium responses alleviate the impact of institutional investors on affordability.

When I split the sample of MSAs based on the housing supply elasticity, the impact of investors on price-to-rent ratio and price-to-income ratio are very different for each subset. In highly inelastic areas, investors affect prices more than rents, whereas in highly elastic areas investors have the opposite effect. As a result, in MSAs with low housing supply elasticity, the short-run fluctuations in prices are much larger than in elastic MSAs, but the opposite effect happens through the housing rents.

These results have important implications for housing policy design. Several cities have enacted policies to block housing investors. For example, California and New York, where institutional investors have a strong and growing presence, recently imposed statewide rent controls (Business Insider 2019). Amsterdam is discussing the ban of institutional investors from buying and renting out houses (Bloomberg 2018; The Guardian 2019), Berlin is considering expropriation of large, profit-seeking landlords (The Wall Street Journal 2019), and Spain recently approved measures that penalize institutional investors (Bloomberg 2019a). The consequence from this study is that there might not be an optimal housing policy that applies to all the different cases.

I organize the rest of the chapter as follows: In Section 1.3 I present and discuss the existing literature. In Section 1.4 I describe the data and data sources. In Section 1.5 I present the

cross-sectional analysis. In Section 1.6 I show the dynamic analysis. In Section 1.7 I assess the validity of the instrumental variable and I perform various robustness checks. In Section 1.8 I present the conclusions.

1.2 Introducción

La asequibilidad de la vivienda es uno de los desafíos políticos más críticos para la mayoría de las ciudades del mundo (Favilukis, Mabile y Van Nieuwerburgh 2019). Por ejemplo, en 2019, en más del 55% de las áreas estadísticas metropolitanas (MSA) de Estados Unidos, el hogar promedio necesitaba al menos tres veces su ingreso anual para comprar una casa de precio medio. La Figura 1.1 muestra que esta falta de asequibilidad se asemeja a la situación durante el gran auge inmobiliario de la década de 2000.

Es curioso que recientemente se ha vuelto común vincular los problemas de asequibilidad con el crecimiento explosivo de los inversores institucionales en los mercados de la vivienda, como, por ejemplo, el Instituto ACCE (Abood 2018), *The Wall Street Journal* (2017) o *The Guardian* (2019). Estas inquietudes están respaldadas por cifras como las que aparecen en la Figura 1.2 que muestra que las MSAs que experimentaron el mayor aumento en la relación precio/ingresos también tuvieron un correspondiente aumento contemporáneo en la participación de mercado de los inversores institucionales.

Funcionarios de varias ciudades han promulgado o están discutiendo políticas para bloquear a los inversores. Por ejemplo, Amsterdam quiere prohibir directamente a los inversores comprar y alquilar propiedades; España impuso recientemente una batería de medidas para penalizarlos; Berlín está considerando expropiar a propietarios grandes, privados y con fines de lucro (*The Wall Street Journal* 2019); Nueva York y California, donde la presencia de inversores institucionales ha alcanzado máximos sin precedentes, recientemente han aprobado controles de alquiler en todo el estado (*Business Insider* 2019).

Este capítulo contribuye al debate anterior utilizando una rica base de datos que cubre todo Estados Unidos, cuantificamos los efectos de los inversores institucionales en los mercados de la vivienda después de la crisis financiera. Muestro evidencia causal de que la presencia de inversores institucionales ha sido un impulsor significativo de la recuperación del precio de la vivienda desde la crisis financiera. Defino a los inversores institucionales como entidades legales que compran viviendas, es decir, compran bajo el nombre de una LLC, LP, Trust, REIT, etc.

Sin embargo, el análisis también muestra un efecto de equilibrio general: los inversores

aumentan la oferta de vivienda y van revirtiendo el crecimiento de los precios. Las casas progresivamente se vuelven más asequibles. En la sección transversal, encuentro que los inversores institucionales aumentan significativamente los precios de la vivienda durante el período 2009-2017, lo que representa 82.7% de la variación transversal del crecimiento de los precios. El efecto es particularmente mayor en el nivel inferior de precios del mercado en relación con el nivel superior. Durante este período los inversores causan un aumento en las nuevas construcciones, lo que aumenta la oferta de viviendas.

Para estudiar los efectos dinámicos de los inversores estimo la respuesta de los precios y las cantidades de viviendas a las compras de los inversores institucionales a lo largo del tiempo, empleando la metodología de Jordà (2005). Esto permite separar el ajuste dinámico en mercados donde la elasticidad de la oferta a corto plazo es relativamente inelástica. Los resultados indican que, en el impacto, las compras de los inversores tienen un efecto positivo en el crecimiento del precio de la vivienda que dura dos años. En el tercer año el impacto en la tasa de crecimiento se vuelve cero, y negativo a partir de entonces. La respuesta de construcción en forma de joroba, combinada con la oferta de vivienda a corto plazo relativamente inelástica, racionaliza los patrones observados. A medida que los inversores inician nuevas construcciones la oferta de viviendas aumenta y las casas se vuelven más baratas y asequibles en las áreas donde los inversores tienen una mayor participación en el mercado. De acuerdo con la teoría, las fluctuaciones en los precios son mucho mayores en áreas con baja elasticidad de oferta.

Este capítulo contribuye a la literatura sobre la asequibilidad de la vivienda. La asequibilidad de la vivienda es uno de los problemas de política más críticos para la mayoría de las grandes ciudades del mundo, y se requiere más investigación para proporcionar información a la política (Deng, Qin y Wu 2019). La literatura ha examinado importantes problemas de accesibilidad relacionados con las políticas gubernamentales, por ejemplo en el Reino Unido (Fingleton 2008; Hilber y Vermeulen 2010), España (Taltavull de La Paz 2007), Australia (Beer, Kearins y Pieters 2007; Taltavull de La Paz y Worthington 2012; Yates 2008), Canadá (Bunting, Walks y Filion 2004; Moore y Skaburskis 2004) y Estados Unidos (Glaeser y Gyourko 2003; Somerville y Mayer 2003). En su influyente artículo, Gyourko, Mayer y Sinai (2013) sugieren que la oferta inelástica de suelo, en combinación con un número creciente de hogares que reciben altos ingresos a nivel nacional en Estados Unidos, conduce a precios persistentes de viviendas altas en grandes MSAs y desplaza a los hogares que reciben menores ingresos. La efectividad de varias políticas destinadas a mejorar la asequibilidad de la vivienda es el núcleo de la literatura reciente.

Este estudio también contribuye a una nueva literatura que se refiere a la aparición de inversores institucionales en los mercados de la vivienda después de la crisis financiera mundial.

Esta literatura se enfoca en viviendas unifamiliares en áreas específicas. Allen y col. (2018) encuentran que las compras de vivienda por parte de inversores en un censo bloque se correlaciona positivamente con los precios de la vivienda en el condado de Miami-Dade en Florida. Mills, Molloy y Zarutskie (2017) documentan que los precios aumentan en áreas con una gran concentración de grandes inversores de compra-alquiler. Lambie-Hanson, Li y Slonkosky (2019) muestran que los compradores institucionales de viviendas unifamiliares contribuyen a un aumento en el alquiler y en el crecimiento de los precios. Su identificación se basa en el programa First Look, un programa que brindó a los hogares y organizaciones sin fines de lucro la oportunidad de ofertar por las propiedades inmobiliarias de Fannie Mae y Freddie Mac antes de que estuvieran disponibles para los inversores.

En relación con la literatura anterior, el capítulo proporciona nuevas ideas sobre los efectos dinámicos de la inversión institucional en los mercados de la vivienda. Este estudio es uno de los primeros en estudiar la dinámica del precio de la vivienda y el efecto de equilibrio general de la oferta, en respuesta a los inversores institucionales. Además, al presentar y defender a fondo una nueva variable instrumental basada en la "actitud de inversión" local en todas las MSAs de Estados Unidos, este trabajo cuantifica la contribución de los inversores a los efectos reales en los mercados de la vivienda y a los efectos diferenciales para los diferentes niveles de precios.

1.3 Literature Review

In this section I review the literature on the determinants of house prices, the theoretical foundations of housing affordability, the affordability problems in advanced economies, the role of supply elasticity and the contribution of housing investors to these problems.

1.3.1 Determinants of house prices

A classical view of house price growth is that it is driven by compensation differentials for areas in which income and productivity are growing faster relative to areas with low growth. However this view is inconsistent with the fact that housing affordability has become a very critical policy issue in most developed cities in the world. Understanding the nature of the affordability problem is key to inform policy makers, as discussed by Deng, Qin, and Wu (2019). This chapter connects two separate strands of literature that explore affordability issues based on how housing prices and rents are determined.

On one hand the traditional approach in the Urban Economics literature brings the focus on regulatory constraints and housing supply as critical drivers of house prices and rents. On the other hand, modern Finance posits that the type of buyers might influence the asset valuations. I summarize the two approaches below. To the best of my knowledge, this study is one of the first to show causal estimates of the impact of a new type of buyers, namely, institutional investors, on housing affordability, in line with the view from Finance. Moreover, I highlight the differential effects for locations with different supply restrictions and the different market segments, connecting these two seemingly separated literatures. I also study the dynamics of these effects in the medium term, when there is time for supply to react.

The traditional approach in Urban Economics focuses on the connection between housing supply and regulatory constraints as a key driver of house prices and rents. The seminal paper by Gyourko, Mayer, and Sinai (2013) suggests that the inelastic supply of land along with an increasing number of high-income households at the national level in the U.S., leads to persistent high house prices in large MSAs and crowds out lower-income households. Their analysis does not determine the effects on rents. Molloy, Nathanson, and Paciorek (2020) develop a dynamic model that predicts that supply constraints should have larger effect on house prices than rents. The implications of the model are consistent with their empirical analysis for the period 1980 to 2016, as they show a strong correlation between supply constraints and house prices, but weak with respect to rents. Consistent with this result, Anenberg (2020) estimates a neighborhood choice model and finds that the rent elasticity of supply is low. The author assesses that marginal increases in new construction due to regulation relaxation are unlikely to meaningfully reduce rents.

Moreover, Makridis (2019) finds that variation in labor costs cannot explain the rise in housing costs, evidence consistent with the standard view that housing costs do not reflect labor costs, but are due to spatial differences in housing and zoning regulation. Ben-Shahar, Gabriel, and Oliner (2020) provide a wonderful summary of new research on housing affordability from the perspective of the Urban Economics literature. This literature abstracts from exploring how the type of housing investors may impact housing prices, rents and affordability. Following from the Urban Economics literature, local supply restrictions generate differential effects on house prices and rents driven by an increase in supply. In this chapter I empirically test these effects.

The view from modern Finance suggests that the type of buyers might affect the asset valuations. This view has been explored by a number of papers that study the effects of investors in the dynamics of house prices using the experience of the housing boom between 2003-2007. A key challenge in this literature is to identify what drove investors to housing

markets. The literature argues that short-term investors (usually referred to as flippers) were driven by access to cheap credit and/or optimistic expectations about house prices. These views have been explored in a number of papers (see for example Agarwal et al. 2019; Albanesi, De Giorgi, and Nosal 2017; Bayer, Mangum and Roberts 2016; Ben-David 2011; Ben-David, Towbin, and Weber 2019; DeFusco, Nathanson, and Zwick 2020; Garcia 2019; Haughwout et al. 2011).

Moreover, Garriga, Manuelli, and Peralta-Alva (2019) show that the presence of credit and optimistic expectations increases house prices relative to income. Following from the Finance literature, this chapter examines the effects of increasing demand for house purchases by institutional investors on house prices, rents, price-to-income ratios and rent-to-income ratios. While the effects of housing investors' demand during the housing boom of 2003-2007 have been widely explored, the rise in investors after the financial crisis of 2008, is a relatively recent development that requires more research (Mills, Molloy, and Zarutskie 2019).

1.3.2 The concept of housing affordability

Housing affordability is a broad term and it is sometimes used to define distinct concepts. It could blend together in a simple term a number of different issues such as the distribution of housing prices, the distribution of household income, the distribution of housing quality, the ability of households to borrow or the ability to repay the mortgage. For example, Gan and Hill (2009) draw a distinction between three main concepts: income affordability (the ratio of house prices to income), purchase affordability (the ability to borrow enough funds to purchase a house), and repayment affordability (the ease of repaying the mortgage). The theoretical foundations of the concept of housing affordability are important to the drawing of the right conclusions from this study. In this chapter I conceptualize affordability in line with the first definition: the price-to-income ratio.

Housing investors may affect affordability through their effects on house prices. The price-to-income ratio is a simple measure, independent of mortgage-related parameters such as the ratio of the down payment, the mortgage-payment per period related to income, the mortgage duration, and the mortgage interest rate. For this reason, it is the most appropriate measure of affordability to use in this study. Another advantage of using the price-to-income ratio is that it can be calculated using readily available data (Bogdon and Can 1997). In this chapter I calculate this ratio at the MSA and County levels within the United States.

Rising house prices may affect in different ways different groups, based on housing tenure.

For example, homeowners benefit from capital gains when house prices rise. The user cost of housing may fall to zero when prices are high enough (Quigley and Raphael, 2004). In the contrary, renters lose from growing house prices. The dynamics of housing prices can be critical for first-time home buyers. Rising house prices prior to the first-home purchase are costly, while rises after purchase act to reduce user cost and are beneficial for the new homeowners. In this chapter I view the concept of affordability as relating moments of the distribution of house prices to moments of the distribution of income. This view abstracts from capital gains on the stock of housing. Thus, the issue of price unaffordability is directly related to potential first-time home buyers.

The specific measure of affordability in this chapter is the ratio of the median house price to the median household income. Moreover, I extend this measure to different quantiles of the price and income distributions. Specifically, besides the median, I use the 17th percentile to capture the lower part of the distributions, and symmetrically the 83rd percentile as a measure for the upper part of the distribution. Gan and Hill (2009) recommend the use of a number of percentiles, since it is likely that the house price and income distributions have different skewness, and different percentiles will give different ratios.

The ratio of the median price to the median income is the most widely used measure of housing affordability. Moreover, the literature on housing affordability has also focused on the lower part of the price and income distributions, indicating that the median might not be enough to measure what are usually more serious problems for low-income households (see for example Hulchanski 1995; Kutty 2005; or Stone 2006). To understand better the effects on low-income households, I also study the price-to-income ratio at the 17th percentile of the price and income distributions, as well as the 83rd percentiles, to compare the effects for high-income households. These specific percentiles (17th and 83rd), along with the median, are the only ones available for the time series of house prices, provided by Zillow. I explain the calculations of the affordability measures in more detail in the Data section.

1.3.3 Housing affordability problems in advanced economies

A well-established literature has studied housing affordability issues in the last decades, especially in developed countries. Wetzstein (2017) examines the emergence of a so-called global crisis of urban housing affordability. According to the author, the affordability crisis is a result of the faster rising of housing-related household expenses in relation to salary increases in many urban centres around the world, which was triggered by economic trends following the global financial crisis.

Housing affordability has been one of the primary public policy focus of economists related to housing. The literature has examined important affordability issues related to government policies, for example in the U.K. (Fingleton 2008; Hilber and Vermeulen 2010), Spain (Taltavull de La Paz 2007), Australia (Beer, Kearins, and Pieters 2007; Taltavull de La Paz and Worthington 2012; Yates 2008), Canada (Bunting, Walks, and Filion 2004; Moore and Skaburskis 2004), and the U.S. (Glaeser and Gyourko 2003; Somerville and Mayer 2003).

The literature has demonstrated affordability issues many decades ago. Although the causes change, the affordability problems remain one of the most important issues concerning housing policy. Bogdon, Silver, and Turner (1994) provide a national account of housing affordability in the U.S. and highlight regional variations and the role of local housing markets in addressing the issues. Focusing on low-income households, Nelson (1994) and Shlay (2006) illustrate the gap between their housing needs and availability of affordable units. Emphasizing the serious consequences of affordability problems, OFlaherty (1996) and Quigley and Raphael (2001) study how unaffordability leads to homelessness.

This chapter examines the role of housing investors in causing affordability problems in different price-tiers of the housing market and in areas with different supply restrictions. While this chapter focuses on the U.S. MSAs, the findings have implications for many developed cities that experienced an increase in housing investors post-crisis.

1.3.4 Supply elasticity, housing prices and affordability

Supply elasticity measures how much the supply changes for a unit change in price. It is commonly accepted that the housing supply is rigid in the short run, since the production of new houses is not immediate (Arnott 1987). That is, the housing supply elasticity is zero in the short-term. As new houses are built over time, the elasticity becomes positive in the long-term. There is consensus in the literature that when house prices increase, new housing supply responds (Mayer and Somerville 2000a). However, the extent of the response depends on the supply elasticity, determined by factors such as building regulation and density (Glaeser, Gyourko, and Saks 2006).

The supply curve rigidity impedes reaching an equilibrium in the housing market in the short run. To reach an equilibrium price, more time is needed for the adjustment of the supply curve (Di Pasquale 1999; Topel and Rosen 1988). Thus, it is important to take in account how the new supply reacts to price changes. Following the theoretical literature, this chapter empirically studies the price effects of an increasing demand for housing by investors, both in

the short-term when the demand curve shifts, and in the long-term, when the supply responds and the price adjusts to equilibrium. It also studies separately the effects in areas of high and low supply elasticity, since supply elasticity is a key factor that determines the reaction of new supply and the price evolution in housing markets (Taltavull de La Paz 2014).

The housing supply literature measures supply either by the total number of existing units in the market (housing stock) (Glaeser and Gyourko 2005; Glaeser, Gyourko, and Saiz 2008; Mayer and Somerville 2000a) or by the number of new units added to the stock (supply flow) (Caldera and Johansson 2013; Malpezzi and Maclellan 2001). In this chapter, I measure the housing supply by the supply flow, by utilizing data from construction permits. The study relates the flow of purchases by investors to the flow of new construction, keeping consistency between these two measures.

The literature supports that supply elasticities differ at local levels, as it shows differences in the responsiveness of new housing supply to prices, for example across Spanish regions (Taltavull de La Paz 2012), across Spanish and Italian regions (Taltavull de La Paz and Gabrielli 2015) or across regions in the U.K. (Ball, Meen, and Nygaard 2010). Important factors that create variations in local supply elasticities are the geographic location (Glaeser and Gyourko 2005; Goodman and Thibodeau 1998), natural geographical restrictions (Saiz 2010), geography, historical patterns of land use and local planning constraints (Ball, Meen, and Nygaard 2010), regulation of residential building (Hilber and Vermeulen 2016; Mayer and Somerville 2000b) and land use restrictions (Gyourko, Saiz, and Summers 2008; Pollakowski and Wachter 1990). Moreover, the literature has linked housing supply regulation to affordability issues. For example, Somerville and Mayer (2003) find that restrictions on the supply of new units contribute to affordability problems, as they impede the supply of affordable units. Molloy (2020) does an excellent review of the effect of housing supply regulation on housing affordability.

Consistent with the literature, I account for the different local supply elasticities to estimate the effects of investors on local housing markets. Following from the previous literature, rise in housing demand by investors would lead to price growth if the supply does not respond to meet the demand. However, there is expected heterogeneity in the house price growth across areas. Areas with higher supply elasticity are expected to have lower price growth compared to areas where the supply elasticity is lower (Taltavull de La Paz and White 2012).

In this chapter the supply elasticity of each metropolitan area in the U.S. has a constant value based on the widely used estimates by Saiz (2010). These elasticities are based on the amount of developable land in each area, estimated using high-accuracy data on terrain characteristics and water presence. The literature has used these elasticity values as a factor driving local housing

markets (Favara and Imbs 2015; Ganong and Shoag 2017; Gyourko, Mayer, and Sinai 2013; Mian and Sufi 2009), to calibrate theoretical models of supply elasticity (Hsieh and Moretti 2019), as an instrument for house prices (Chaney, Sraer, and Thesmar 2012; Mian and Sufi 2011), or as an instrument for local exposure to the housing boom-bust cycle (Mian, Rao, and Sufi 2013). I use the elasticities per MSA to show different outcomes in housing markets for high- and low-elasticity MSAs.

1.3.5 Housing investors

The aftermath of the financial crisis, with collapsing housing prices, substantial availability of foreclosed and real estate owned homes, tight mortgage lending to households, dramatically decreasing risk-free rates, and technological advances created the conditions for the emergence of a new class of investors in the housing markets. These investors purchased multiple properties with the purpose of generating rental income. This is in-line with the traditional housing and macro models where housing investors are attracted by rental income as documented by Chambers, Garriga, and Schlagenhauf (2009). The novel fact, is that these investors are not individuals, but are incorporate as legal entities, such as Limited Liability Companies, Trusts, Limited Partnerships etc. I use the term institutional investors to describe these legal entities.

In one of the first papers to study the emergence of the post-crisis institutional investors in the U.S. housing markets, Mills, Molloy, and Zarutskie (2019) document that several large firms purchased single-family homes, created large portfolios of rental properties and securitized these investments in capital markets. The authors identify as a main factor attracting investors to these markets the ample supply of property for sale, tight mortgage financing and a decrease in acquisition and managerial costs brought about by technological advances. These large buy-to-rent investors appear to have supported house prices in the neighborhoods where they concentrated their investments, although the findings are not causal.

Aiming to provide a causal identification of the effects of large investors, Lambie-Hanson, Li, and Slonkosky (2019) use as identification strategy the First Look program that gave households and non-profits an opportunity to bid on real estate owned properties before they became available to investors. They find that the purchases of large institutional investors increased price and rent growth. Lambie-Hanson, Li, and Slonkosky (2019) describe the rise of institutional investors in the largest cities in the U.S.

Mills, Molloy, and Zarutskie (2019) classify the institutional investors based on their size, that is, the number of properties they owned. During the years 2007 to 2014 the large investors

that owned more than 50 properties, where about 20% of the total investors, whereas investors with more than 120 properties were less than 3% of the total investors. Often, large investors are attracted to large cities with more rapid growth of house prices. This chapter contributes to the debate about the effects of institutional investors by separating purchases from small and large institutional investors.

Recent papers have focused on the large housing investors: private equity firms with lots of capital, that entered the U.S. single-family housing market to take advantage of the distressed market from 2012 onwards. Blackstone's Invitation Homes, American Homes 4 Rent, Progress Residential, and Cerberus Capital Management are some of these large investors. Ganduri, Xiao, and Xiao (2019) find that the bulk purchases of distressed single-family homes by large institutional investors had a positive spillover on nearby home values. Gallin and Verbrugge (2019) find that multi-unit landlords, when renegotiating rent contracts, set rent increases that exceed the inflation rate, aided by the law of large numbers and exploiting tenant moving costs. A strand of the literature explores the role of institutional investors in the single-family housing market, by focusing on specific cities with large investors' presence. Allen et al. (2018) use data from Miami-Dade County in Florida and find that an increase in the share of houses purchased by large investors in a census block is related to an increase in house prices. Raymond et al. (2018) find that large institutional owners of single-family rentals file more frequently eviction notices compared to small landlords in Fulton County in Atlanta.

Relative to purchases by local investors, part of the literature explores the contribution of deep-pocket foreign and out-of-town investors raising housing prices and reducing the local supply of owner and tenant-occupied housing. Taltavull de La Paz, López, and Juárez (2017) show that large flows of foreign homeowners cause house price increases that spill over to areas with mainly local demand in Alicante, Spain. Chinco and Mayer (2015) explore the contribution of out-of-town second-house buyers to house price growth in U.S. MSAs. Cvijanovic and Spaenjers (2020) estimate the causal effect of out-of-country buyers on house prices in Paris. Davids and Georg (2020) show an increase in house purchases by foreign non-residents in Cape Town, South Africa, when the currency exchange rate is depreciates. Favilukis and Van Nieuwerburgh (2018) show that capital inflows from out-of-town home buyers is associated with increases in house prices and worsening affordability, by calibrating a spatial equilibrium model of a city to the New York and Vancouver metro areas.

Related to this literature, this chapter is one of the first to classify the institutional investors post-crisis in all U.S. MSAs and study their causal effects on the housing markets. It undertakes a comprehensive data exercise to classify investors based on the buyer name, as well as clean the data from any market intermediaries like relocation companies, NGOs, mortgage lenders

or the state taking ownership of foreclosed properties. This chapter provides novel evidence for the housing affordability dynamics in response to institutional investors, and the equilibrium response of supply in the long run. Moreover, by introducing and thoroughly defending a novel instrumental variable based on local “propensity to invest”, this chapter quantifies the contribution of housing investors to real economy.

1.4 Data

I include a detailed description of the variables and data sources in the Appendix A1. Data on investors in the U.S. housing market come from the Zillow Transaction and Assessment Dataset (ZTRAX, Zillow 2017). The database covers all ownership transfers as recorded by the counties’ deeds. I focus on ownership transfers of residential properties, including multi-family and single-family, from January 1st, 2000 to December 31st, 2017. The final sample, from which I construct the investors’ purchases variable, consists of around 85 million transactions.

I follow a rigorous methodology to classify institutional investors. First, I distinguish between investors and homeowners, by classifying as investors the buyers who purchase two or more houses within the same MSA over a period of two years, in line with the definition of housing investors in the recent literature (Bayer, Mangum, and Roberts 2016). With this definition, if a buyer purchases a house in an MSA and within two years a second house in a different MSA they are considered homeowners. This way I avoid classifying as investors homeowners who own a vacation home in a different MSA than their main residence.

Second, I distinguish between individual and non-individual investors based on the buyer name in the deed. Allen et al. 2018 use the same classification method utilizing deeds data from a different source.

Third, I clean up the institutional investors from market intermediaries. I filter out buyers that are relocation companies, NGOs, construction companies, national or regional authorities, mortgage lenders, GSEs, and the state taking ownership of foreclosed properties.

Fourth, the variable of institutional investors’ purchases is the share of the dollar value of purchases by institutional investors over the dollar value of all purchases, that is, by institutional investors, individual investors and homeowners. Using the dollar value is the most appropriate measure given the data. For example, the number of purchases would underestimate presence in the apartments market, as the number of purchases would equate a purchase of one condominium to the purchase of one apartment building of 100 apartments. For robustness checks I

use alternative measures of the presence of investors based on the number of properties or the number of units purchased.

The instrument uses zip code data of individual tax returns from the Statistics of Income of the Internal Revenue Services (IRS). It is the average share of business income over total income of high earners (annual adjusted gross income above \$100K) in each MSA in 2007. I weight by the total income of high-earners to aggregate to the MSA level. To construct the panel version of the instrument, I use the average one-year certificate of deposits (CD) rate from Bankrate, a consumer financial services company.

I use the Zillow Home Value Index for all homes, single-family homes, top-tier homes and bottom-tier homes at the MSA level. The Zillow Home Value Index is a dollar-denominated, smoothed, seasonally adjusted measure of the median estimated home value across a given region and housing type. The bottom-tier segment of the market is the bottom third of the housing price distribution in each MSA. The bottom-tier price is the median price of the segment, that is, the bottom 17th percentile of the prices of the total market within an MSA. In a symmetrical way, the top-tier segment of the market is the top third of the price distribution in each MSA, and the top-tier price is the top 83rd percentile of prices within an MSA.

Housing rents come from the Zillow Rent Index for all homes, a dollar-denominated, smoothed, seasonally adjusted measure of the median estimated rent across a given region and housing type. I adjust the annual price growth and annual rent growth for inflation, using the Personal Consumption Expenditures price index (PCE) issued by the Bureau of Economic Analysis.

I collect the number of new construction permits from the Census Bureau's annual Building Permits Survey, and the number of vacant housing units from the American Community Survey. Finally, population comes from the Census, the unemployment rate from the Bureau of Labor Statistics, and income from the Statistics of Income of the IRS and Zillow. I calculate the 17th, 50th and 83rd percentiles of individual income from the IRS to get the price-to-income ratio for the corresponding tiers.

Table 1.1*a*, summarizes the key statistics of the cross-sectional sample. There are 332 MSAs with the full set of average housing variables and investors' market share for the years 2009-2017, control variables beginning in 2000, and tax-returns for the year 2007. On average, investors purchase 12.37% of the market annually, over 2009-2017. Prices for a median house grow on average by 0.47 annually in real terms, while for an individual with median income, the price-to-income ratio is 4.76 on average.

Table 1.1*b*, summarizes the key panel variables, at the MSA-year level, I use in the dynamic analysis. The panel data contains 332 MSAs for 9 years, from 2009 to 2017. 332 MSAs for 9

years result in 2,988 observations.

1.5 Investors and Affordability in the Cross-Section

My goal is to study the effects of institutional investors on housing affordability. Figure 1.2 suggests that institutional investors could have been an important driver of housing price growth after the financial crisis. More formally, first I run the following cross-sectional regressions:

$$y_{m,09-17} = \beta_0 + \beta_1 Inst_{m,09-17} + \gamma C_m + \alpha_s + u_m, \quad (1.1)$$

where $y_{m,09-17}$ denotes the relevant housing variables for a given MSA indexed by m and for the period 2009-2017. The housing variables I study are the average annual real housing price growth rate and the price-to-income ratio for different price and income percentiles. $Inst_{m,09-17}$ is the average share of institutional investors' dollar value of purchases over the total purchases in MSA m over the same period. The term C_m summarizes the MSA-specific controls: population growth, income growth, unemployment rate change and real housing price growth over the periods 2000-2006 and 2006-2007. I also control for the log number of building permits in 2007, to account for new supply. The term α_s includes state dummies to account for the time-invariant state-specific influences.

A direct OLS estimation of specification (1.1) is likely to suffer from two sources of bias, sample selection and reverse causality. I address these two problems below.

Potential selection bias would arise if the institutional investors were selecting properties not at random. For example if the investors were selecting properties of lower than average price range, or with higher potential for price growth. That is, there would be an omitted variable in the regression that determines both the share of the market value that investors buy (independent/endogenous variable) and the price growth (dependent variable). This is a likely scenario. To address this, I do not use the actual prices of the houses the investors purchased to construct the dependent variable. I instead use a price index, that shows how the prices evolve for different price-tiers. The price indexes I use are based on repeated sales, a methodology pioneered by Shiller (1991), which addresses exactly this problem of selection bias in a broader form: The houses sold and bought are not randomly distributed among all houses. For example, in their classical papers, Case and Shiller (1989; 1990) show evidence of excess returns and inefficiencies in housing markets. Similarly, by using indexes for the dependent variables, such as rent growth and affordability, I avoid that the dependent and independent variables are co-determined by the selection of houses by institutional investors.

A problem of reverse causality is likely to bias the estimates downwards. This is because the estimates might capture the effect of investors targeting MSAs where prices fell more after the crisis and were slow to pick up. To overcome this problem, I use an instrument for the investors' market share of purchases. Section 1.7.6 discusses another instrument as robustness.

1.5.1 The instrumental variable: Propensity for investing

I use an instrumental variable that allows me to exploit variation in the geographical presence of investors and that is plausibly exogenous to other drivers of housing markets. This instrument is the average share of value of business income over total income of the top earners in an MSA for the year 2007. Top earners are residents that file total income larger than \$100K in their tax returns, and they are the ones most likely to have the scope to invest in housing.⁷

The economic rationale for this instrument is that it measures the local exposure to the sharp drop in returns of safe assets caused by the unconventional monetary policy shock during the financial crisis. The QE programs reduced the supply of safe assets in the market. The federal funds rate and the returns on certificates of deposits and other safe assets fell close to zero. This national shock triggered a search for yield (Martínez-Miera and Repullo 2017; Rodnyansky and Darmouni 2017; Daniel, Garlappi, and Xiao 2018; Campbell and Sigalov 2020). Areas with high-earning, knowledgeable, risk-seeking investors experienced higher investment in the local housing markets. Consistent with this theory, De Stefani (2020) documents that the investment attitude towards housing increased significantly among the wealthy U.S. population following the financial crisis.

Crucially for the validity of the identification, the share of business income is uncorrelated with factors that drive housing markets, conditional on the multiple controls. The literature on entrepreneurship finds that it is very hard to explain geographical differences in entrepreneurship (Davidsson 1991; Rocha and Sternberg 2005; Bosma and Kelley 2019). Section 1.7 contains an array of tests that all suggest that the instrument satisfies the exclusion restriction. That is, given the various controls for observable factors, exposure to top earners' business income in 2007 is uncorrelated with other drivers of housing markets over 2009-2017.

Table 1.2 assesses the relevance of the instrument, showing the results of the first stage of the 2-stage least squares (2SLS) regression based on specification (1.1). After controlling for the relevant MSA-level controls, and state dummies, the instrument is significantly correlated

⁷As robustness tests, I have also constructed instruments using the average share of business income in the MSA and different moments of the distribution. The results, not reported here, hold for different versions of the instrumental variable.

with the investors' purchases. The Wald F statistic, reported in Table 1.3, allows to reject that the instrument is weak.

1.5.2 Cross-sectional results

Table 1.3 summarizes the effects of institutional investors on housing price growth and on the price-to-income ratio, by price and income tier, over the period 2009-2017. The first column reports the OLS estimation of (1.1) for the median house price and median income. The smaller coefficient of the OLS estimation is consistent with the expected downward bias of the OLS, since the prices were falling significantly up to 2012, and investors were likely to select areas where prices collapsed. From the summary statistics (Table 1.1a) the average growth in real housing prices between 2009 and 2017 was 0.47%. The results show that the effect of investors was to prevent even larger drops in housing prices and eventually recover the positive growth.

Looking at the standardized estimates,⁸ Table 1.3 shows that one standard deviation higher purchases by institutional investors (7.78% from Table 1.1a) causes 0.827 standard deviations, or 1.46 percentage points, higher housing price growth for the median house.⁹ However, the largest effects are on the bottom price tier of the market. For this bottom tier, one standard deviation higher purchases causes 0.909 standard deviations, or 2.29 percentage points, higher housing price growth.¹⁰

Turning to price-to-income ratio, Table 1.3 also shows positive effects, that are also larger for the bottom price tier of the market. For example, from Table 1.1a we know that the average price-to-income ratio in the bottom tier of the market is 8.48. If we add the change caused by one standard deviation higher purchases by investors then the ratio becomes around 20.¹¹

The findings are robust to excluding superstar cities. These are the areas that are heavily affected by purchases coming from Wall Street investors. Table 1.4 replicates the analysis from Table 1.3 for two different samples: first excluding the top 10 cities, and second excluding the top 20 cities based on large investors' purchases. The results from Table 1.4 show that all effects become larger as I remove the top cities. For example, one percentage point increase in the share of investors' purchases increases bottom-tier price-to-income by 1.538 in the full sample, 1.540 in the sample without the top 10 superstar cities, and 1.728 in the sample without the

⁸The standardized estimates use the standardized share of investors and standardized dependent variables, for easier comparison and derivation of the economic significance of the results. I restrict the sample of the standardized variables to the MSAs for which Zillow has housing prices for all price tiers, to facilitate comparison.

⁹That is, 0.827 from Table 1.3 multiplied by 1.77 from Table 1.1a.

¹⁰That is, 0.909 from Table 1.3 multiplied by 2.52 from Table 1.1a.

¹¹That is, adding 8.48 from Table 1.1a plus the product of 2.108 from Table 1.3 and 5.48 from Table 1.1a.

top 20 superstar cities.

To check the robustness of the results to the geographical unit, I perform the same analysis with counties instead of MSAs. Table A1 shows that the results remain unchanged when I use counties.

1.6 Dynamic Real Effects of Investors

This section studies how the response of housing prices and quantities to the institutional investors' purchases changes over time. I follow Jordà (2005) and estimate sequential regressions of the dependent variable shifted forward.¹² That is, I estimate:

$$y_{m,t+i} = \beta_0 + \beta_1^{(i)} Inst_{m,t-1} + \beta_2 y_{m,t-1} + \gamma C_{m,t-1} + \alpha_m + b_t + u_{m,t}, \quad (1.2)$$

where t indexes years and m MSAs, and $y_{m,t}$ denotes the housing variables: real housing price growth rate from year $t-1$ to year t , for top, mid and bottom tier houses, the price-to-income and rent-to-income ratios, the price-to-rent ratio, the log number of new construction permits, and the log number of vacant units of owner-occupied homes.

$Inst_{m,t-1}$ is the institutional investors' share of dollar value of purchases over the total market value for the year $t-1$ in MSA m . $C_{m,t-1}$ are the time-varying MSA-specific controls that include the population growth rate, the median income growth rate, and the unemployment rate change. The location fixed effects α_m capture the time-invariant MSA-specific influences, and the time fixed effects b_t account for the time-varying factors common to all MSAs, like national mortgage rates. I include a lagged dependent variable $y_{m,t-1}$ to allow the growth response to be temporary, as explained in Favara and Imbs (2015) that apply the same methodology to study house prices.

The important controls to include in the regression model are the ones that would cause omitted variable bias if not included, as the focus is on the accurate estimation of the causal effect. It is therefore critical to control for the economic variables that are likely to affect both the housing variables and the share of investors. This is primarily the role of the fixed effects as well, as common fixed factors within MSAs or within years are likely to have an influence on attracting investors as well as driving the housing markets.

To test the robustness of the specification to different controls, I show that the results do not

¹²Favara and Imbs (2015) also apply this method to study house prices, and Mian, Sufi and Verner (2017) to study GDP growth.

change when controlling for contemporaneous income and population growth, and unemployment rate change, instead of the lagged variables. In addition, using both the contemporaneous and lagged values of these controls, like in Favara and Imbs (2015), again yields the same results.

The estimate of interest is the vector of $\{\beta_1^{(i)}\}$, where $i = 0, 1, \dots, 6$ is the time horizon of the response, that is, the number of years after the investors' purchases. Each $\beta_1^{(i)}$ corresponds to the effect of investors' share of purchases at horizon i . When $i = 0$, this gives the usual panel specification. I estimate (1.2) for the full panel data from 2009 to 2017. When $i = 0$ the estimated $\beta_1^{(0)}$ gives the average effects of the fbw of investors in 2008-2016 on annual price growth for the years 2009-2017. That is growth from 2008 to 2009, 2009 to 2010, ..., 2016 to 2017. When $i = 1$ the estimated $\beta_1^{(1)}$ gives the average effects of the fbw of investors in 2008-2015 on annual price growth for the years 2010-2017. When $i = 2$ the estimated $\beta_1^{(2)}$ gives the average effects of the fbw of investors in 2008-2014 on annual price growth for the years 2011-2017, etc.

In the estimation I cluster standard errors by MSA to allow for within-MSA correlation throughout the sample period, following the recommendations in Bertrand, Duffo, and Mulainathan (2004) and Angrist and Pischke (2009). The results remain unchanged when I alternatively allow for Newey-West standard errors that allow for heteroskedasticity and within-MSA serial autocorrelation of the error term.

For the analysis, I employ the panel version of the instrumental variable defined as the 2007 local exposure to top earners' business income interacted with the certificate of deposits (CD) interest rate growth. The idea is that QE triggered a national shock to the CD rate, which is equal for all locations and it is not driven by local factors. The exposure of each location to the national shock is unrelated to local factors affecting the housing markets, as I assess in Section 1.7. The exposure is also predetermined, fixed in 2007, which minimizes the possibility of reverse causality. Thus, this instrument captures which MSAs are more likely to have housing investors after the QE policies. The rationale for the panel instrument is analogous to the housing net worth channel of Mian and Sufi (2014) that exposes certain areas to larger macro effects from declines in housing prices due to their housing leverage. In this case, investment-prone areas are exposed to the QE shock. Table 1.5 shows that the relevance condition is satisfied. Section 1.7 assesses the exogeneity condition, which is derived from the cross-sectional dimension.

The dynamic effect of purchases by institutional investors varies over time as illustrated in Figures 1.3 to 1.7 that display the results from the instrumental variable estimation of specification (1.2). Tables 1.6 and 1.7 have the results of the estimation. Initially, the purchases of institutional investors have positive effects on prices and rents. However, the positive dy-

namics on house prices disappear in the third year and in the fourth for rents. The cumulative responses in Figure 1.3 confirm that after three years from the investors' purchase shock we cannot rule out zero effect of the investors on housing price and rent growth. Figure 1.4 shows an average result across MSAs for the effects of investors' purchases on price-to-income and rent-to-income ratios.

The larger short-run effect in the panel regressions, relative to the cross-section results, is due to the lack of response of the housing supply. Notice that the response of new construction, in Figure 1.5, measured by building permits, is a hump shape that peaks after two or three years and remains positive for several years. In other words, investors generate price increases that motivate a strong response from housing supply that mitigates the affordability concerns.

Another way to look at this supply reaction is to look at vacancies in Figure 1.5. Ben-David, Towbin, and Weber (2019) argue that one way to identify housing booms is to look at the response of vacancies for owner-occupied and rental houses. In the short-term the number of vacancies decreases as investors purchases meet an inelastic supply of housing. The number of vacancies increases as new constructions arrive to the market.

Consistent with the supply response, the effects on price-to-income and price-to-rent ratio differ once I split the sample of MSAs by the housing supply elasticity. The average effects (from Figure 1.4) look very different based on the housing supply elasticity of the area, as I show in Figures 1.6 and 1.7. In highly inelastic areas, the short-run fluctuations in prices and worsening of price affordability are much larger than in MSAs with high supply elasticity. In other words, in these areas with low supply elasticity, investors drive prices and don't seem to move rents in the short-run. As a result the price-to-rent ratio increases, the price-to-income ratio also increases, and the rent-to-income ratio is constant. In areas with high supply elasticity the opposite effect is true. The price-to-rent ratio decreases in the short run and most of the effect on affordability comes from rents and not prices.

1.7 Validity of the Instrument

In this section I assess the validity of the instrumental variable and the robustness of the previous results. I examine at length the exclusion restriction. Section 1.5.1 already showed that the instrumental variable is relevant as it is strongly correlated with the investors' share of purchases. Figure A1 provides visual support of the strong correlation between the instrument and the share of investors' purchases over 2009-2017, while Figure A2 supports visually the relevance condition for the panel version of the instrument.

The instrumental variable in the cross-section is the share of income reported as business income in 2007 by high-earner residents. In the panel and dynamic analyses, this share measures the exposure of each MSA to the national shock of the sudden drop in interest rates. Using a Bartik-like instrument is equivalent to using the local shares as instruments, hence the exclusion restriction should be interpreted in terms of the shares (Goldsmith-Pinkham, Sorkin, and Swift 2020).¹³

The identification concern for the instrumental variable is whether the exposure of the local investors to the drop of interest rates is correlated with changes in housing prices that come through channels other than property purchases. In their seminal paper, Goldsmith-Pinkham, Sorkin, and Swift (2020) set out the strategies to test for the validity of Bartik-like instruments, which I employ in this setting.¹⁴

I do the following exercises: (1) parallel pre-trends and placebo tests; (2) extensive local economy controls; (3) controls for shifts in the composition of labor demand; (4) exploration of predictors of business income and inspection of correlation with standard drivers of housing markets. Finally, I show the robustness of the results to alternative specifications and definitions of investor purchases, and an alternative instrument for credit supply previously used in the finance literature.

1.7.1 Parallel pre-trends

The use of a Bartik-like instrument and the availability of pre-period trends, make the empirical strategy analogous to difference-in-differences. In a difference-in-differences setting the MSAs with the largest exposure to business income of top earners in 2007 is the treated group, and the MSAs with the smallest exposure is the control group. The year 2008 is the “treatment” year, when the Fed implemented the first wave of unconventional monetary policy, which led to a large drop in interest rates and caused an increase in investors, especially in the MSAs with higher investment attitude.

Figure 1.8 plots the annual log number of building permits and the annual real price growth

¹³While a typical shift-share instrument utilizes the inner product of local exposure (e.g. industry shares) and local growth rates, we can think of this instrument as using only one relevant weight - the business income share of the top tier of the income distribution - times the national shock of the drop in CD rates.

¹⁴"Because the shares are typically equilibrium objects and likely co-determined with the level of the outcome of interest, it can be hard to assume that the shares are uncorrelated with the levels of the outcome. But this assumption is not necessary for the empirical strategy to be valid. Instead, the strategy asks whether differential exposure to common shocks leads to differential changes in the outcome. (...) Hence, the empirical strategy can be valid even if the shares are correlated with the levels of the outcomes" (Goldsmith-Pinkham, Sorkin, and Swift Forthcoming, p.2).

of bottom-tier homes for MSAs ranking in the top and bottom 25% of exposure to top earners' business income in 2007. Figure 1.8 shows that prior to the shock there are parallel dynamics in housing construction and prices between the high and low exposure groups. The divergence starts post-2008. That is, in the period when QE does not exist and there are no incentives to have investors into housing markets, the MSAs behave similarly. I only see differences during and after the QE period when the MSAs more exposed to potential investors see those investors move to the housing market in search for yields.¹⁵ The parallel pre-trends suggest that the instrument is driving construction and prices only in the post-crisis period. In other words, the instrument is not capturing other factors that could make housing prices to have permanently different dynamics across locations. The empirical design satisfies the parallel pre-trends, an important assessment towards the plausibility of the exogeneity assumption (Goldsmith-Pinkham, Sorkin, and Swift 2020).

In a similar analysis, I run a placebo test with the pre-crisis period 2000-2006 when QE was not operating and thus institutional investors were not actively seeking for yield (Figure 1.9). The scatter plots control for the same variables as specification (1.1). The MSAs are binned by percentiles so that each point represents around 15 MSAs. The bottom panel of the figure demonstrates strong positive correlation between the instrument and housing price growth over 2009-2017. This correlation is absent in the pre-crisis placebo sample that is in the top panel. This evidence suggests that the instrument is not contaminated by pre-crisis price growth.

To check for potential outliers, I replicate Figure 1.9 with the same data but showing 100 quantile groups. The scatter plots in Figure A3 confirm visually that there are no large outliers that might be influencing the results.

To confirm the message from Figure 1.9, I conduct various placebo tests over the 2000-2006, 2001-2006, and 2000-2005 periods in Table 1.8. The selection of placebo periods is restricted by a lower bound of the year 2000, since this is when the investors' data begin. The upper bound is 2006, to avoid an overlap and potential co-determination of the investors' share and the instrumental variable that is constructed using 2007 data. I ask if, when using a specification analogous to (1.1), the exposure to the top earners' business income can explain housing price growth over any of these periods. The placebo point estimates are insignificant across periods. That is, the instrument is only capturing post-crisis positive shocks in housing investment. None of the factors operating pre-QE period are correlated with the instrument.

¹⁵Consistent with the dynamic results, Figure 1.8 shows that the largest positive effect in the housing price growth due to investors happens in the first three years, while the response of construction is positive throughout the post-crisis period.

Table A2 contains the results of placebo tests for the panel analysis, for pre-crisis periods. Figure A4 plots a placebo experiment linking the instrument to prices, and Figure A5 to new construction. The instrument does not contribute to changes in prices or number of construction permits in time periods pre-crisis. Overall the above tests indicate that the instrument is unrelated to drivers of changes in housing markets that operate through different channels, other than the exposure to the national shock in interest rates.

1.7.2 Contemporaneous local economy controls

To rule out the possibility that local economic conditions drive the results, Table 1.9 reestimates the baseline specification controlling for a range of variables that capture contemporaneous local economic activity: average annual unemployment rate change, labor force participation growth, real GDP per capita growth, and median hourly wage per capita growth from 2009 to 2017. It is not clear that these variables are good controls, since they can be part of the transmission channel of the effect of investors. Nevertheless, Table 1.9 displays results very similar to Table 1.3.

Importantly, the estimated coefficients are in close range (plus-minus 8 percent) of the baseline coefficient of 0.234 from Table 1.3. A large change in the coefficient would hint at omitted variables biasing the estimation. The results alleviate concerns of omitted variable bias. These results suggest that the local economic activity and the institutional investors are both important for housing price growth, but investors also affect housing markets even when keeping local economic activity constant.

1.7.3 Controls for spacial spillovers

While I include several controls for economic conditions, a remaining concern is that the instrument is likely to be correlated with the industrial composition of the local labor market, and therefore related to shifts in the composition of labor demand during the post-crisis period.¹⁶ To address this concern I reestimate the baseline specification controlling for changes in employment in the largest industry sectors within the MSAs (Table 1.10).

The changes are accounted for, starting from the base year of the instrumental variable, that is, from the annual change from 2007 to 2008, up to the annual change from 2016 to 2017.

¹⁶For example, Monte, Redding, and Rossi-Hansberg (2018) study the importance of spatial spillovers due to local labor demand shocks through changes in commuting patterns.

Employment changes in some industries, such as Real Estate, Rental and Leasing could be considered bad controls, as they might be part of the transmission channel of the investment effect on prices. Even with this prudent analysis, after controlling for employment growth of up to ten industries, the estimated effect of investors holds, and it is close to the baseline effect. Having the estimated coefficient within the range of the previous estimations in Table 1.9 provide extra confidence that the controls for observables capture the influential factors. It is unlikely that the instrument is correlated with any remaining unobserved drivers of housing prices.

Moreover, Table A3 reestimates the dynamic results accounting for the lagged annual shifts in the composition of labor demand. The dynamic patterns of housing price growth remain unchanged when I include the employment growth controls for the largest industries in the MSAs. The shifts in the composition of labor demand during the post-crisis period do not seem to be driving the results.

1.7.4 Unpredictable instrumental variable

Ideally, for the identification to be valid, we would have that the cross-MSA differences in the share of business income is random. The parallel pre-trends that I documented earlier, show that the share of business income was not related to the housing market dynamics before 2008. In addition to the previous result, I show that it is very difficult to predict the share of business income, or the investment/entrepreneurship attitude of an MSA, based on a variety of factors that the literature found to be linked to those attitudes.

In the introduction I discuss papers showing that most of the cross-regional differences in investment attitude are as good as random. I confirm this result in Table 1.11. I regress the share of the top earners' business income in each MSA in 2007 on several factors that may explain investment or entrepreneurship activity. These factors are demographic (median age and share of immigrants), regulatory (tax rate for high earners), geographical (natural amenity index) and the ranking of MSAs in the ease of doing business. While some of these factors are correlated with the top earners' business income, their explanatory power is low. The demographic and regulatory factors explain 11% of the variation in the top earners' business income share, as we see by the R-squared of the first column of Table 1.11. Including the geographical factor the R-squared becomes 22%.

Moreover, in Table 1.12 I study whether the standard drivers of the housing market are correlated with the instrument, given the controls. I regress the local share of top earners'

business income on the pre-crisis trends of homeownership and median age within each MSA. To better gauge the magnitude of these partial correlations, the table normalizes all variables to have a mean of zero and a variance of one. This allows to assess both the magnitude and statistical significance of any correlations. Importantly, there is no relevant correlation between the common drivers of housing variables and the MSA share of top earners' business income.

Thus, the failure to predict the instrument indicates that large part of the variation in this share is random, unrelated to other drivers of housing markets. Moreover, given the expansive set of controls I include in all the specifications, the exclusion restriction for the instrument seems satisfied.

1.7.5 Robustness to other specifications

I check that the core results survive to changes in the specifications. For example, Figure A6 plots the estimated impulse responses for the top and bottom price tiers in the panel case. Consistent with the cross-sectional evidence, I find that investors have larger effects on the bottom-tier of the market.

I redo the analysis only for the single-family segment of the housing market. Table A4 shows that the response of prices to investors is exactly as statistically significant in the single-family segment as in the total market.¹⁷ The lower panel of Table A4 shows the results of the analysis for single-unit properties, which are again as statistically significant as the results for the total market.

I use additional controls in all models, to control for total demand for housing or demand for housing by institutional investors. These controls are the total dollar value of purchases in the market or the total dollar value of purchases by investors. Controlling for either of these levels of demand does not change any of the results.¹⁸ The baseline controls (population, income, unemployment, MSA and year fixed effects) already capture a large part of the variation in housing demand.

Table A5 shows that the results are robust to using alternative measures of investors' share based on number of purchases and number of units.

¹⁷Ninety percent of the properties in the Zillow Home Value Index are single-family and the rest are condominiums and cooperatives.

¹⁸I do not report the tables of these results, as they are similar to the previous results.

1.7.6 Robustness to alternative instruments

Finally, I assess the sensitivity of the results to using a different instrumental variable. This alternative instrument is based on credit constraints to households as in Gete and Reher (2018). The mechanism is that some MSAs were exposed to credit shocks following the Dodd-Frank Act, approved in 2010. MSAs with larger reliance on the heavily regulated banks suffered larger contraction in credit towards borrowers. As those households retreated, it was easier to investors to expand.

As in Gete and Reher (2018), I use MSA exposure to lenders subject to a Comprehensive Capital Analysis and Review (CCAR) stress test from 2011 onwards.¹⁹ I use the 2008 bank distribution, determined prior to Dodd-Frank, to minimize the risk of reverse causality. The CCAR test, like other stress tests, is meant to ensure that the largest bank holding companies have enough capital to weather a financial crisis, but as a side-effect it encourages those institutions to tighten their standards in mortgage markets (Calem, Correa, and Lee 2020).

Table A6 shows the estimates of (1.2), using the credit denial instrument. While the estimates are larger in magnitude, the results confirm that the response of prices is initially positive and becomes significantly negative in the medium term. Table A6 also shows results using both the baseline instrumental variable, based on business income, and the alternative one, based on credit constraints. The results are robust to the use of both instrumental variables.

1.8 Conclusions

The explosive growth of investors in residential housing markets after the Global Financial Crisis has been central to many affordability debates. Cities around the world are designing policies to deal with these new investors. By analyzing a large database covering the whole U.S., this chapter showed that the immediate response of price-to-income and rent-to-income ratios to the investors' purchases is positive and economically significant. Investors drove most of the recovery in housing prices in low-tier housing. In the short-term, the purchases by investors increase prices and worsen housing affordability. The effects are the largest on homes at the bottom of the price distribution, while the influence on the top tier market (i.e. luxury houses) is small.

¹⁹Formally, the instrument is the value of deposits' share in 2008 for lenders that underwent the CCAR stress test between 2011 and 2017 in MSA m multiplied by the difference in denial propensity between stress-tested and non stress-tested lenders in year $t - 1$.

In the medium-term (1 to 3 years), the analysis indicates that the presence of investors triggered a strong equilibrium response of supply with a substantial positive effect on new building permits. The continued purchases by investors in a market with growing supply mitigated the growth of price-to-income and rent-to-income ratios.

Are these effects uniform across MSAs? In principle MSAs can vary in many dimensions and the analysis controls for that to assess the average impact of investors' purchases. However, an important dimension is the potential influence of the housing supply elasticity. In some areas, house price increases can have muted supply responses due to regulation and construction restrictions. In other areas, the restrictions are minimal and prices are often determined by the cost of new construction. This analysis shows that in areas with loose supply restrictions investors affected rents more than prices, whereas the opposite is true for areas with strict supply restrictions.

Combining the implications of these findings, this study indicates that policy interventions to improve affordability should not only take into consideration the short-run effects, but also the medium- and long-run effects that consider the potential supply response. In this situation the role of investors could be important to stimulate the supply of new housing units. Obviously, there are cities where supply is hard to expand. In those cases, more research is needed about the optimal housing policies.

1.9 Conclusiones

El fuerte crecimiento de los inversores en los mercados de viviendas residenciales después de la Crisis Financiera Mundial ha sido fundamental en muchos debates sobre la asequibilidad. Las ciudades de todo el mundo están diseñando políticas para tratar con estos nuevos inversores. Al analizar una gran base de datos que cubre todo Estados Unidos este estudio mostró que la respuesta inmediata de las relaciones precio-ingreso y alquiler-ingreso a las compras de los inversores es positiva y económicamente significativa. Los inversores impulsaron la mayor parte de la recuperación de los precios de la vivienda en viviendas de bajo nivel.

A corto plazo, las compras de los inversores aumentan los precios y empeoran la asequibilidad de la vivienda. Los efectos son mayores en las casas que se encuentran en la parte inferior de la distribución de precios, mientras que la influencia en el mercado de nivel superior (es decir, casas de lujo) es pequeña.

En el mediano plazo (1 a 3 años), el análisis indica que la presencia de inversores desencadenó

una fuerte respuesta de equilibrio de la oferta con un efecto positivo sustancial en las licencias de obra nueva. Las compras continuas por parte de los inversores en un mercado con una oferta creciente mitigaron el crecimiento de las relaciones precio-ingreso y alquiler-ingreso.

¿Son estos efectos uniformes en todas las MSA? En principio, las MSAs pueden variar en muchas dimensiones y el análisis controla eso para evaluar el impacto promedio de las compras de los inversores. Sin embargo, una dimensión importante es la influencia potencial de la elasticidad de la oferta de vivienda. En algunas áreas, los aumentos de los precios de la vivienda pueden haber silenciado las respuestas de la oferta debido a las regulaciones y restricciones de construcción. En otras áreas, las restricciones son mínimas y los precios suelen estar determinados por el costo de la nueva construcción. Este análisis muestra que, en áreas con restricciones de oferta flexibles, los inversores afectaron más las rentas que los precios, mientras que lo contrario es cierto para áreas con restricciones estrictas de oferta.

Combinando las implicaciones de estos hallazgos, este estudio indica que las intervenciones de políticas para mejorar la asequibilidad no solo deben tomar en consideración los efectos a corto plazo, sino también los efectos a mediano y largo plazo que consideran la respuesta potencial de la oferta. En esta situación, el papel de los inversores podría ser importante para estimular la oferta de nuevas viviendas. Obviamente, hay ciudades donde la oferta es difícil de expandir. En esos casos, se necesita más investigación sobre las políticas óptimas de asequibilidad.

Figures

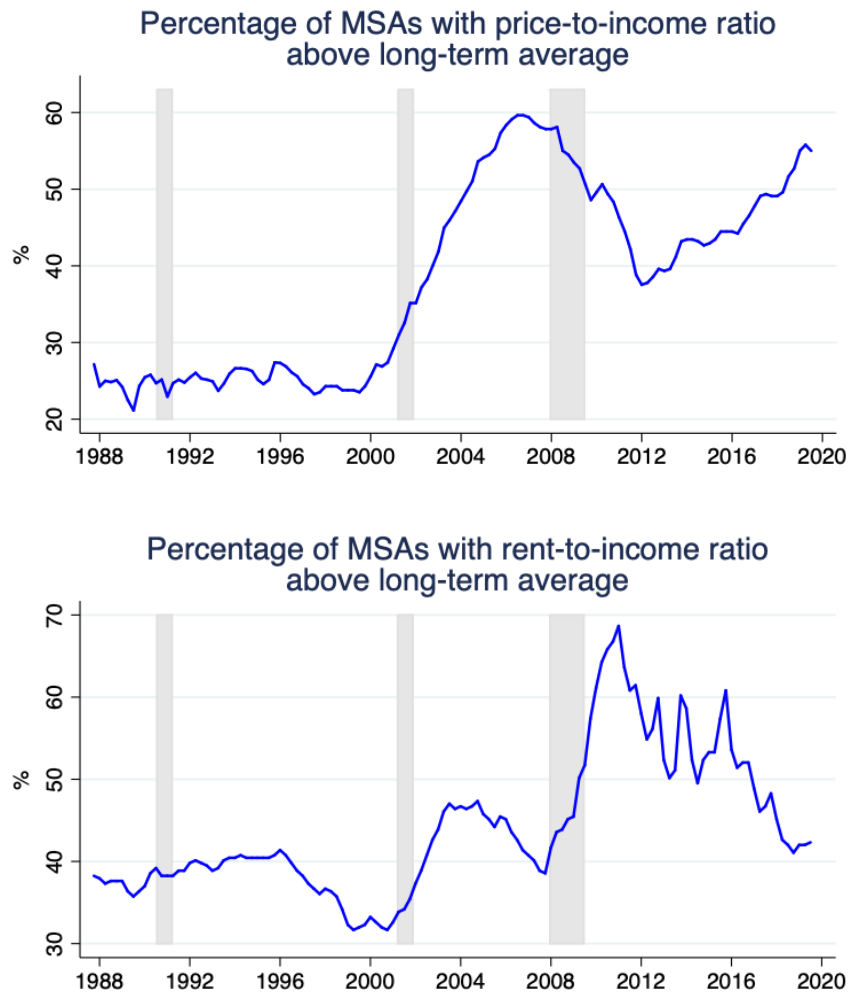


Figure 1.1. Housing affordability in the U.S. relative to long-term average. The top figure plots the share of MSAs where price-to-income ratio is above three, which has been the national average in the U.S. over 1987-2019. That is, the share of MSAs where the median housing price is higher than three times the median annual household income. The bottom figure plots the share of MSAs where rent-to-income ratio is above 0.27, the national average over 1987-2019. That is, the share of MSAs where the median annual housing rent is higher than 27 percent of the median annual household income. The gray areas illustrate the U.S. Recessions. The price-to-income and rent-to-income ratios come from Zillow.

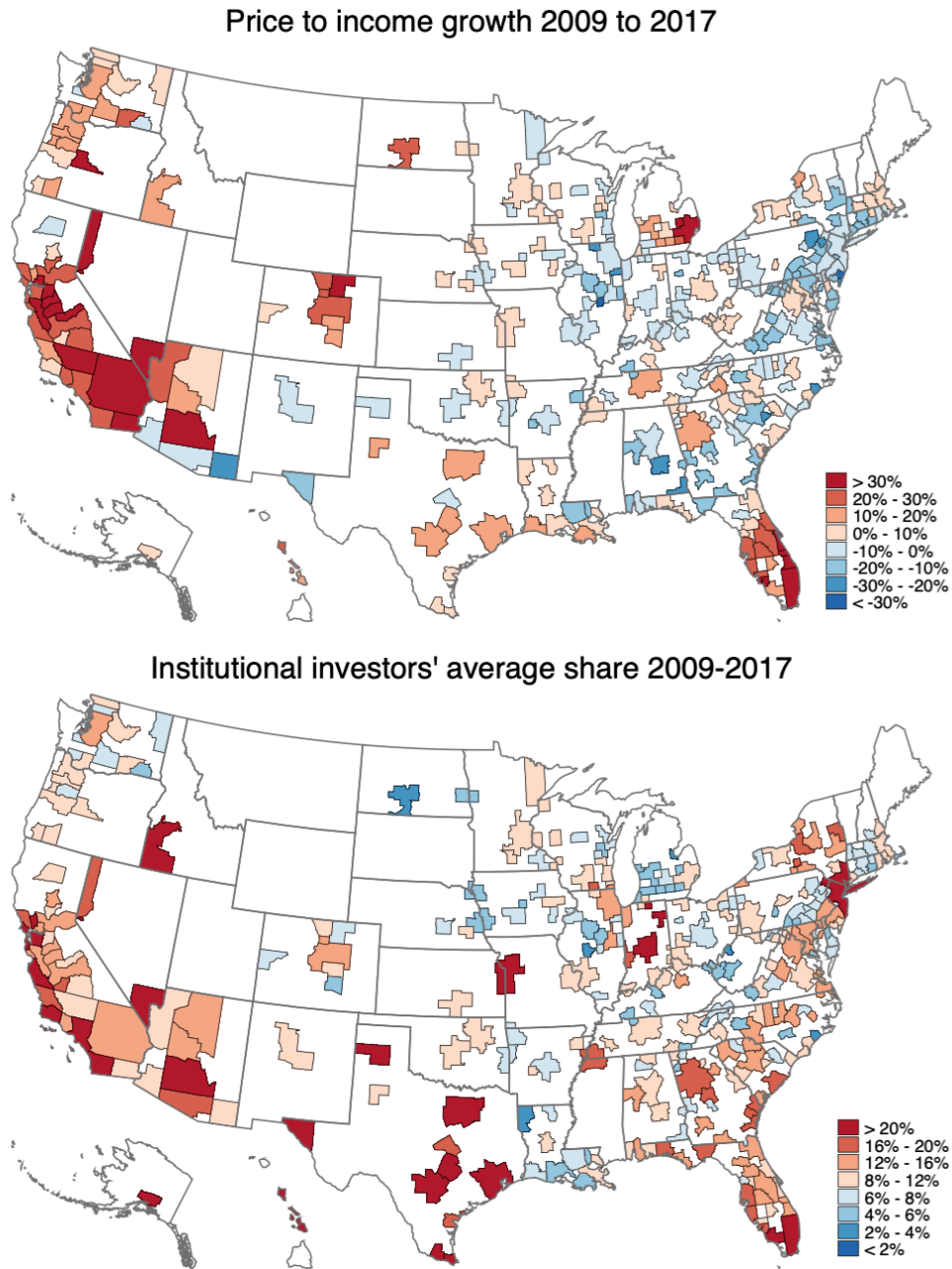


Figure 1.2. Affordability and institutional investors in the U.S. The top map shows the percentage growth of price-to-income ratio from 2009 to 2017 in each MSA. The bottom map shows the average market share of dollar purchases by institutional investors from 2009 to 2017 in each MSA. Source: Zillow.

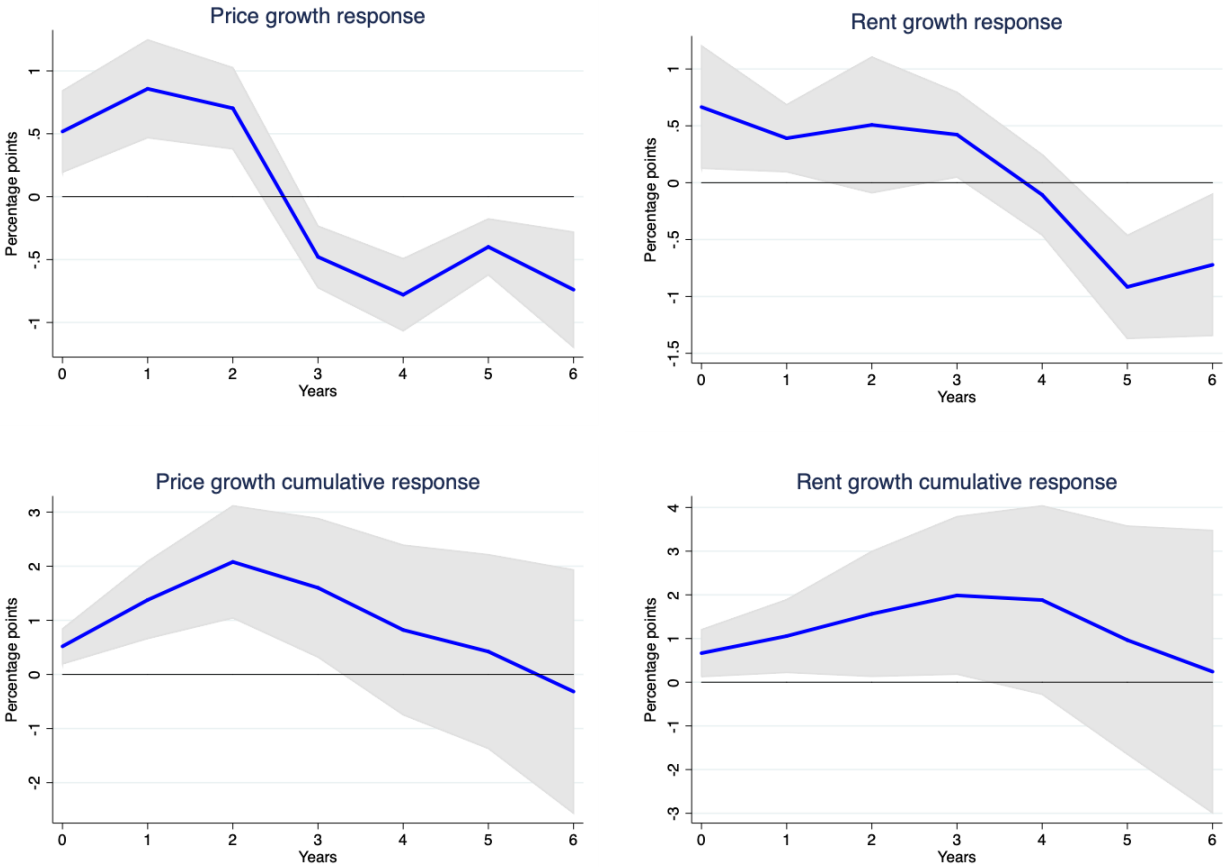


Figure 1.3. Dynamics of housing prices and rents after investors' purchases.

The top figures plot the estimates from sequential regressions of the price growth and rent growth on the instrumented past investors' share of purchases. The bottom figures plot the cumulative effects, calculated as the cumulative sum of the previous coefficients. Prices and rents are adjusted for inflation. Section 1.6 contains the methodology that follows Jordà (2005). I estimate the impulse responses for the full panel data from 2009 to 2017. The shaded areas show the 90% confidence interval.

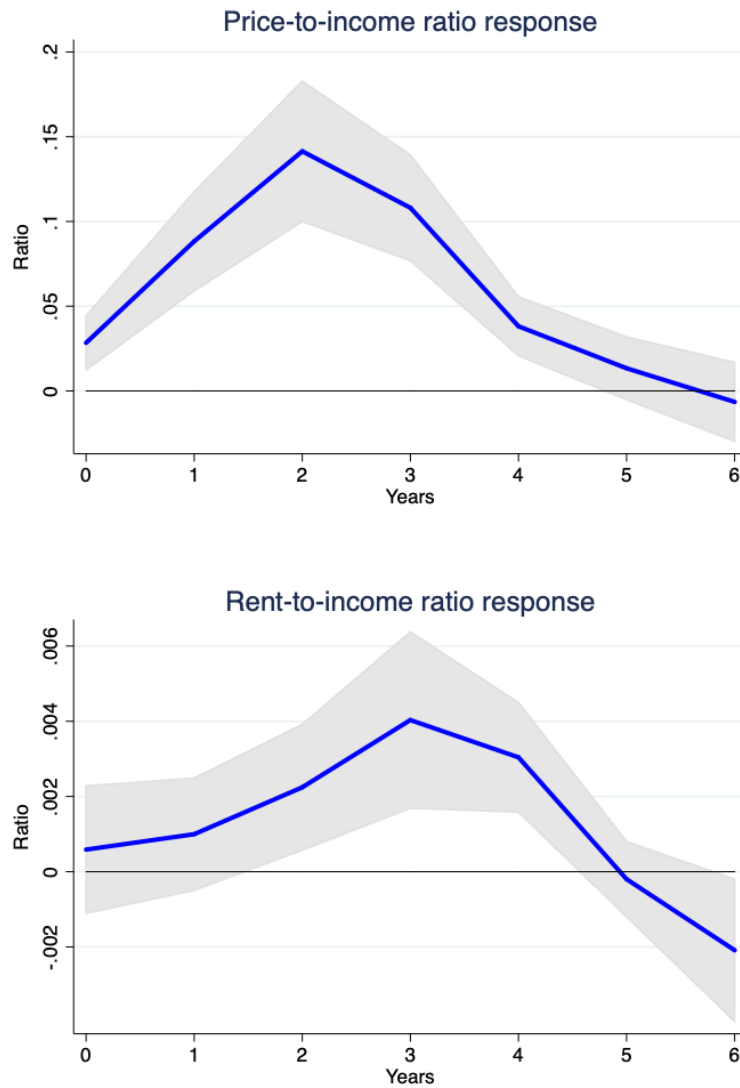


Figure 1.4. Dynamics of housing affordability after investors' purchases. The figures plot the estimates from sequential regressions of (a) the price-to-income ratio, and (b) the rent-to-income ratio on the instrumented past investors' share of purchases. The price-to-income ratio is the median housing price over the median annual household income in an MSA. The rent-to-income ratio is the median annual housing rent over the median annual household income in an MSA. I estimate the impulse responses for the full panel data from 2009 to 2017. The shaded areas show the 90% confidence interval.

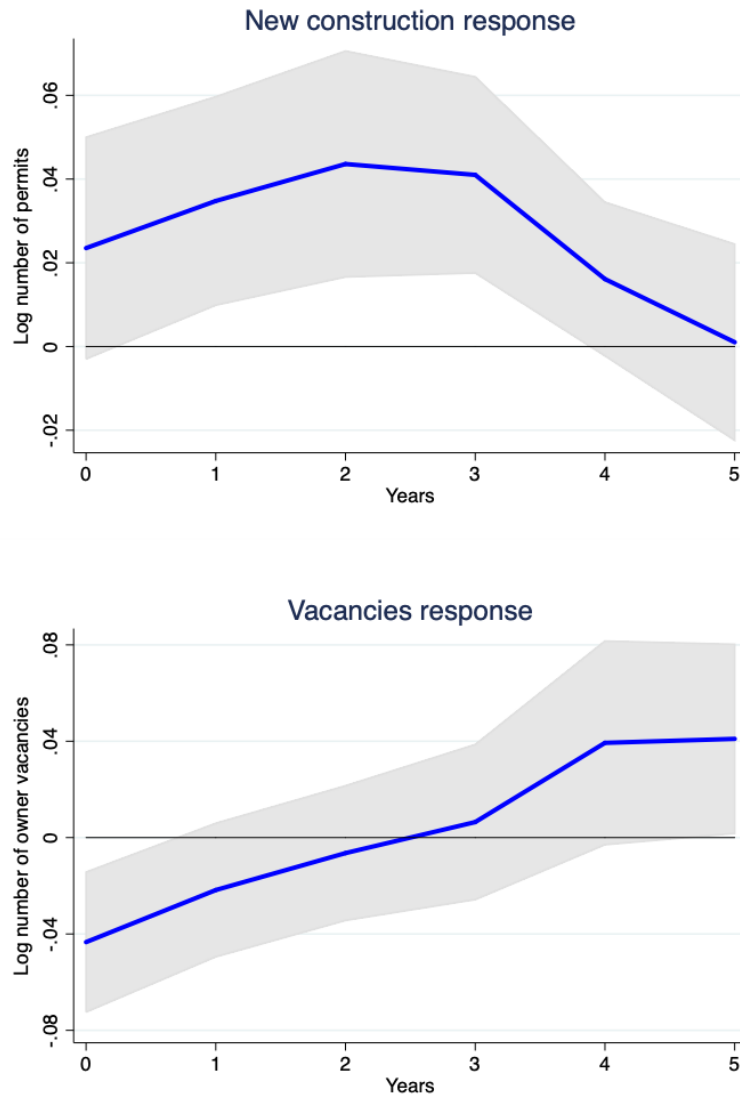


Figure 1.5. Dynamics of housing supply after investors' purchases. The figure plots the estimates from sequential regressions of (a) the log number of building permits, and (b) the log number of homeowner vacant units on the instrumented past investors' share of purchases. I estimate the impulse responses for the full panel data from 2009 to 2017. The shaded areas show the 90% confidence interval.

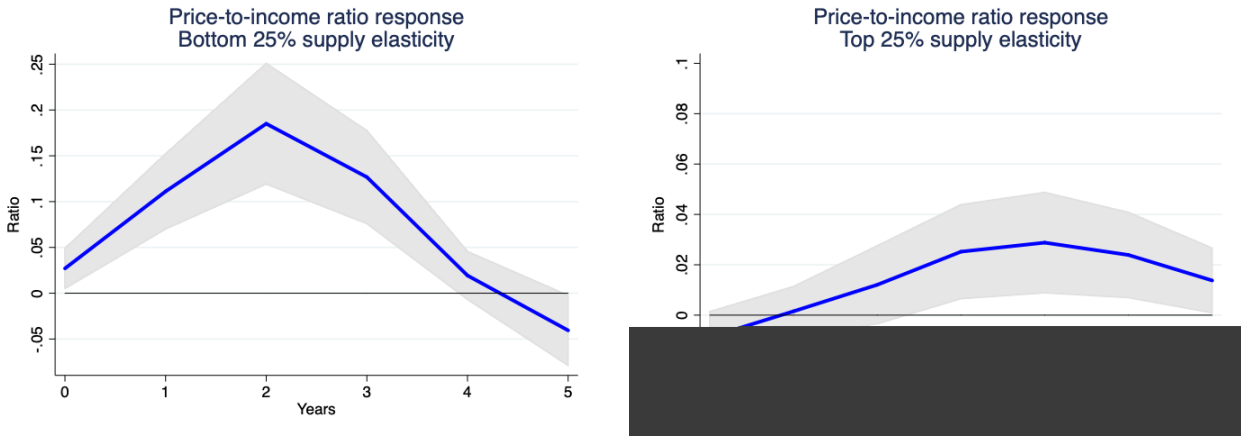


Figure 1.6. Dynamics of housing affordability after investors' purchases and supply elasticity. The figure plots the estimates from sequential regressions of (a) the price-to-income ratio, and (b) the rent-to-income ratio for MSAs at the bottom and top quartiles of the supply elasticity distribution. The housing supply elasticity comes from Saiz (2010). The bottom quartile of the supply elasticity is 1.57, and the top quartile is 3.18 in the sample (see Table A10). The bottom quartile has an average price-to-income ratio of 4.2 and rent-to-income ratio of 0.33, over 2009-2017. The top quartile has an average price-to-income ratio of 2.5 and rent-to-income ratio of 0.27, over the same period. I estimate the impulse responses for the full panel data from 2009 to 2017. The shaded areas show the 90% confidence interval.

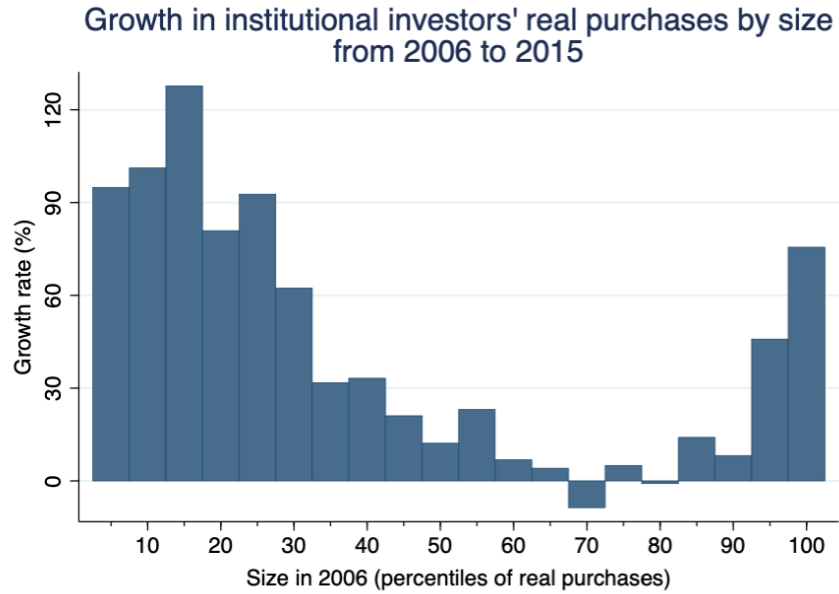


Figure 2.3. Growth of institutional investors by size. The figure plots the growth in dollar purchases by institutional investors from 2006 to 2015 in each percentile segment of purchase value. The percentile cutoffs are the dollar values of the cutoffs in 2006. All dollar values are in 2006 dollars. Figure B1 in the appendix shows the change in the number of investors (extensive margin) over the same period.

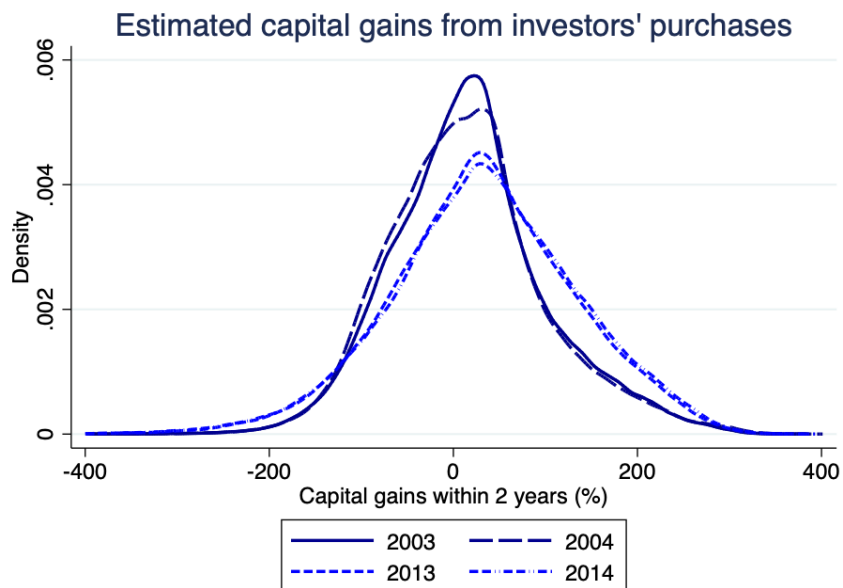


Figure 2.4. Capital gains from housing purchases by investors pre- and post-crisis. The figure shows the estimated capital gains within two years for all housing purchases by investors in the years 2003, 2004, 2013, and 2014. The sale price is estimated using a hedonic regression. The capital gain is the percentage increase from the purchase to the sale price of each property.

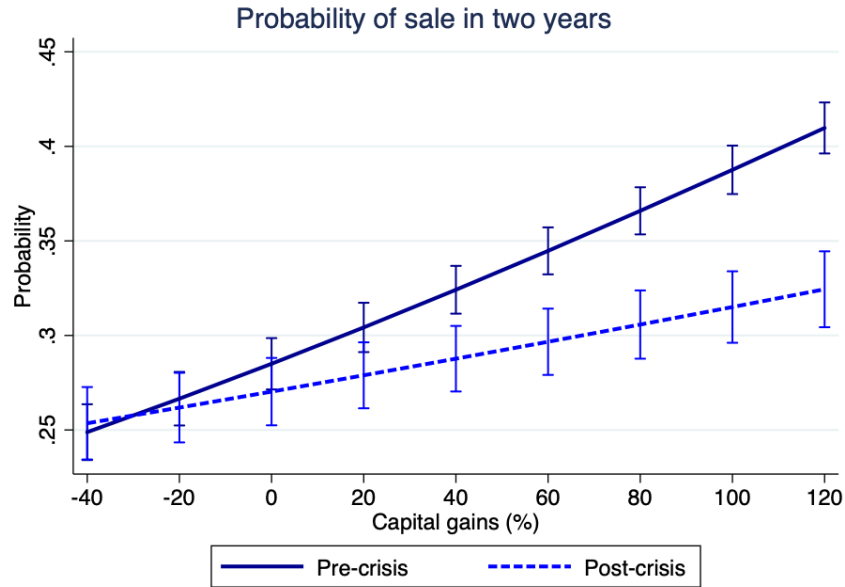


Figure 2.5. Probability of sale in two years pre- and post-crisis. The figure plots the estimated probability of short-term sale (sale within two years from the month of purchase) for the properties purchased by investors pre-crisis during 2003 and 2004, and post-crisis during 2013 and 2014. The vertical lines show the 90% confidence intervals. The probabilities are derived from the estimation of the logit model (2.2) described in Section 2.6.2, and shown in Table 2.3.

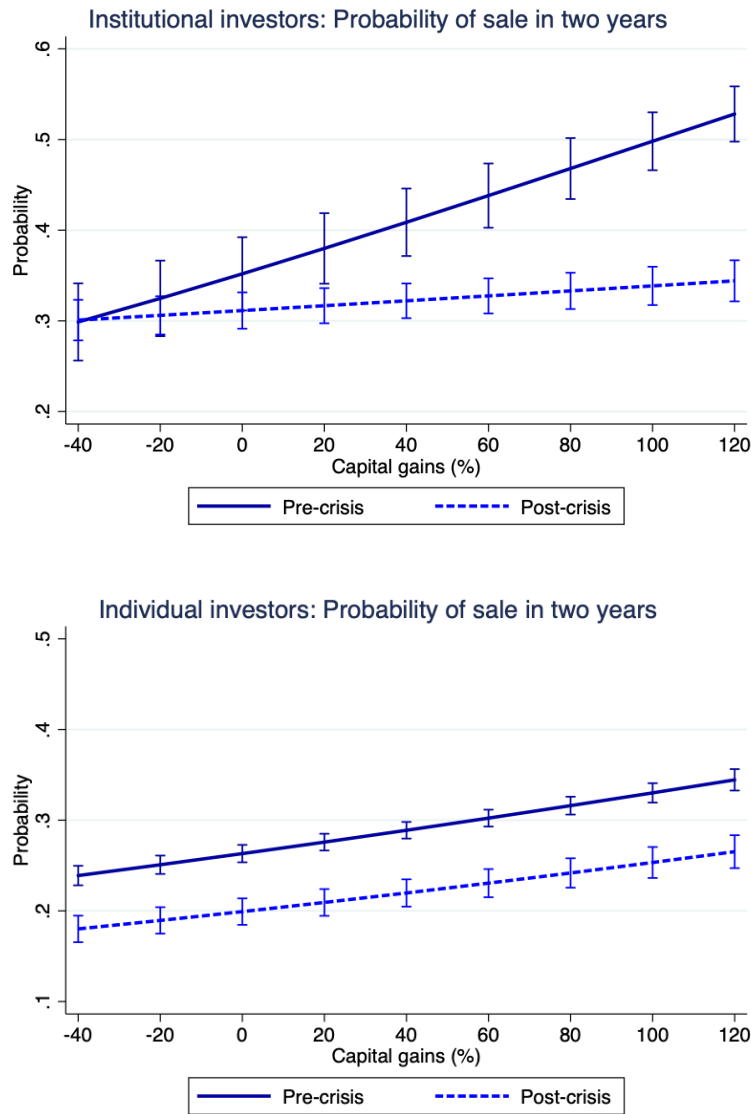


Figure 2.6. Probability of sale in two years pre- and post-crisis by type of investor. The top figure plots the estimated probability of short-term sale (sale within two years from the month of purchase) by institutional investors for the properties purchased by investors pre- and post-crisis. The bottom figure plots the same estimated probabilities for individual investors. The vertical lines show the 90% confidence intervals. The probabilities are derived from the estimation of the logit model (2.2) described in Section 2.6.2.

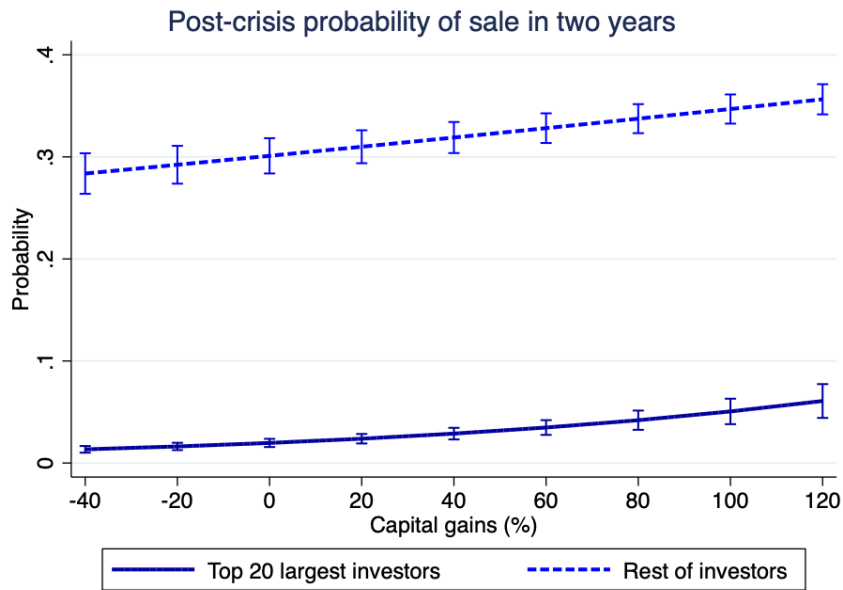


Figure 2.7. Probability of sale in two years post-crisis by investor size. The figure plots the estimated probability of short-term sale (sale within two years from the month of purchase) for the properties purchased by investors post-crisis, for the largest institutional investors in the single-family rental market, and the rest of the investors. The vertical lines show the 90% confidence intervals. The probabilities are derived from the estimation of the logit model (2.3) described in Section 2.6.2, and shown in Table 2.4.

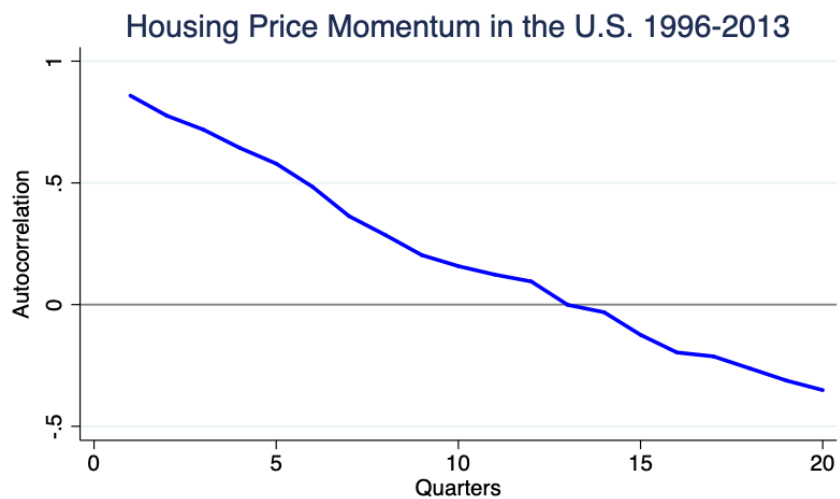


Figure 2.8. Housing price momentum in the U.S. The figure plots the autocorrelation of the national house prices in the U.S. for different quarterly intervals. The data cover the period from the first quarter of 1996 to the last quarter of 2013.

Tables

Table 2.1*a*. Summary statistics of the variables in the hedonic regression

Year		Obs.	Mean	SD	P5	P95
2003	Log price	135,940	12.01	0.82	10.55	13.28
	Size	135,940	8.99	1.07	7.26	10.81
	Age	135,940	35.68	30.12	0	91
	Last renovation	135,940	32.20	28.87	0	88
2004	Log price	181,639	12.16	0.83	10.66	13.38
	Size	181,639	8.96	1.12	7.22	10.81
	Age	181,639	35.16	30.58	0	92
	Last renovation	181,639	31.65	29.18	0	88
2013	Log price	135,348	12.08	0.89	10.43	13.43
	Size	135,348	9.10	1.05	7.54	10.95
	Age	135,348	42.81	28.79	3	93
	Last renovation	135,348	38.93	28.00	0	91
2014	Log price	125,017	12.08	0.91	10.43	13.48
	Size	125,017	9.10	1.06	7.54	10.93
	Age	125,017	45.27	28.69	5	94
	Last renovation	125,017	40.89	28.10	1	94

This table presents summary statistics of the key variables in the hedonic regressions. The sample consists of all residential property purchases by institutional and individual investors in 2003, 2004, 2013 and 2014, which I track until their next sale. P5 is the 5th percentile and P95 is the 95th percentile. The construction of the hedonic database is described in Table *B1*.

Table 2.1*b*. Summary statistics at property and county level

	Pre-crisis (purchases 2003-04)				Post-crisis (purchases 2013-14)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Sale in two years	0.30	0.46	0	1	0.30	0.46	0	1
Capital gain (%)	15.25	79.21	-170	253	32.86	95.59	-236	262
Avg. population growth (%)	1.74	1.92	-1.65	11.25	1.13	0.95	-7.13	12.17
Avg. income growth (%)	5.53	2.16	-2.89	20.11	4.16	1.59	-15.12	10.76
Avg. unempl. rate change (pp)	-0.43	0.35	-1.7	0.95	-0.94	0.41	-2.35	1.55
Observations	1,115,296				953,266			

This table presents summary statistics of the key variables in the estimations at the property purchase level. The sample consists of all residential property purchases by institutional and individual investors in 2003, 2004, 2013 and 2014, which I track until their next sale. Capital gains are calculated from the hedonic regression. Population growth, per capita income growth and unemployment rate change are at the county level.

Table 2.1c. Summary statistics at the MSA level

	Obs	Mean	SD	Min	Max
Investors' share of purchases ₀₀₋₀₅ (%)	327	16.28	13.84	0.00	63.75
Investors' share of purchases ₀₉₋₁₇ (%)	344	18.45	9.47	4.97	54.51
Momentum ₀₀₋₀₅	327	0.10	0.47	-0.92	0.91
Momentum ₀₉₋₁₇	344	0.47	0.31	-0.70	0.94
Time on the market (days) ₀₉₋₁₇	344	108.33	21.64	56.18	194.98
Log house price ₁₉₉₈	327	11.81	0.34	10.92	13.03
Log population ₁₉₉₈	327	12.57	1.06	10.44	16.39
Log income ₁₉₉₈	327	10.57	0.16	10.10	11.11
Log house price ₂₀₀₇	344	12.13	0.48	11.12	13.57
Log population ₂₀₀₇	344	12.68	1.07	10.48	16.43
Log income ₂₀₀₇	344	10.79	0.18	10.33	11.36

This table presents summary statistics of the key variables in the estimations at the MSA level. The sample includes all MSAs with complete data.

Table 2.2. Hedonic estimation results

Year	2003	2004	2013	2014
	Log Price			
Size	0.130*** (0.002)	0.129*** (0.002)	0.129*** (0.002)	0.130*** (0.002)
Age	-0.225*** (0.017)	-0.236*** (0.014)	-0.203*** (0.016)	-0.202*** (0.016)
Last renovation	-0.407*** (0.018)	-0.396*** (0.015)	-0.494*** (0.016)	-0.514*** (0.017)
Zip code dummies	Yes	Yes	Yes	Yes
R-squared	0.617	0.630	0.700	0.703
Observations	135,940	181,639	135,348	125,017

Standard errors are in parentheses. The years indicate the year of the purchase of the property. Size is the size of the property, measured in log square feet, age is the number of years from the time the property was built, and last renovation is the number of years since the last renovation. The coefficients and standard errors for age and last renovation are multiplied by 100. Each observation is a property. ***sig. at 1%.

Table 2.3. Probability of short-term sale and investors

	Short-term sale (sale in two years from purchase)		
Capital gain	0.297*** (0.029)	0.428*** (0.031)	0.466*** (0.028)
Capital gain \times Post-crisis		-0.232*** (0.038)	-0.248*** (0.046)
Post-crisis		0.018 (0.061)	-0.074 (0.052)
County-level controls	No	No	Yes
Observations	2,068,562	2,068,562	2,041,615
Number of counties	924	924	895

Robust standard errors clustered by county are in parentheses. The coefficients and standard errors of capital gains and the interaction are multiplied by 100. The county controls are the average growth in population, growth in per capita income, and change in unemployment rate for two years from the property purchase. Table B3 tests the robustness of the results to different durations. ***sig. at 1%.

Table 2.4. Post-crisis: Probability of short-term sale and investors

	Short-term sale (sale in two years from purchase)	
Capital gain	0.210*** (0.034)	0.208*** (0.028)
Capital gain \times Top investors	0.765*** (0.130)	
Top investors	-3.069*** (0.133)	
Capital gain \times Out-of-town buyer		-0.108* (0.060)
Out-of-town buyer		-0.041 (0.088)
Capital gain \times Foreign buyer		0.098 (0.080)
Foreign buyer		-1.200*** (0.089)
County-level controls	Yes	Yes
Observations	946,797	858,567
Number of counties	892	823

Robust standard errors clustered by county are in parentheses. The coefficients and standard errors of capital gains and the interaction are multiplied by 100. The county controls are the average growth in population, growth in per capita income, and change in unemployment rate for two years from the property purchase. Table B3 tests the robustness of the results to different durations. ***sig. at 1%; *sig. at 10%.

Table 2.5. Housing price momentum and investors' share

Years	2000-2005	2009-2017
	Price momentum	
Investors' share $m_{,00-05}$	0.003** (0.001)	
Investors' share $m_{,09-17}$		-0.004** (0.001)
MSA-level controls	Yes	Yes
Observations	327	344

Heteroskedasticity robust errors are in parentheses. Momentum is the one-year serial autocorrelation of annual log real price changes, calculated from quarterly prices. Controls are the log population, log income and log real price in 1998 in the first column, and 2007 in the second column. All models include state dummies. Each observation is an MSA. **sig. at 5%.

Table 2.6. Time on the market and investors' share

	Time on the market _{<i>m,09-17</i>}
Investors' share _{<i>m,09-17</i>}	-0.463*** (0.117)
MSA-level controls	Yes
Observations	344

Heteroskedasticity robust standard errors are in parentheses. Controls are the log population, log income and log real price in 2007. Each observation is an MSA. ***sig. at 1%.

Chapter 3

Investors in the Market for Mortgage Risk

3.1 Introduction

The mortgage market in the U.S. has been at the core of the financial crisis of 2007-2009, as the mortgage system was struggling to deal with the massive mortgage defaults. Up to 1.5% of mortgages started foreclosure proceedings at the peak of the crisis, while the historical average from 1990 to 2006 was 0.4% (Corbae and Quintin 2015). The Government Sponsored Enterprises (GSE), Fannie Mae and Freddie Mac, who were guaranteeing mortgage payments for loans securitized in mortgage backed securities, became financially distressed. This led to their conservatorship under the Federal Housing Finance Agency (FHFA) in September 2008. At the start of their conservatorship, the GSEs held or guaranteed about \$5.2 trillion of home mortgage debt. In effect, during the last twelve years, the U.S. taxpayers have been backing almost all securitized mortgages through the GSEs.

Most proposals to reform the housing finance system suggested to transfer risk to capital markets, through an extended use of the Credit Risk Transfers (CRTs) that Fannie Mae and Freddie Mac pioneered in 2013 (Levitin and Wachter 2020).²⁵ The CRTs are structured securities with multiple tranches that rank the losses in case of mortgage defaults. Their performance is linked to the credit performance of pools of mortgages underlying agency mortgage backed securities (MBS). The Federal Housing Finance Agency (FHFA), asked Fannie Mae and Freddie

²⁵The most widely used CRT mechanism has been the issuance of synthetic notes –Fannie Mae’s Connecticut Avenue Securities (CAS) and Freddie Mac’s Structured Agency Credit Risk (STACR) securities. I refer to these notes as CRTs’

Mac to use the CRTs to transfer much of their credit risk to institutional investors.

Between 2013 and 2018, Fannie Mae and Freddie Mac have transferred a portion of the credit risk associated with \$2.8 trillion of unpaid principal balance; with a combined risk-in-force of about \$91 billion (3.3% of unpaid principal balance). In 2018, 73% of single-family mortgages acquired by the GSEs were targeted for CRT.

A key policy question for a reformed system is how capital markets will react during a period of market stress. More broadly, most policy reforms propose a dramatic size reduction of the GSEs. Such a reform will require dramatic changes to the mortgage rates. In a mortgage market without the GSEs, what would be the implications of market stress on mortgage rates? How would the mortgage market perform through the economic cycle? These chapter aims to provide answers to these questions.

I exploit the timing of Hurricane Harvey in Houston, Texas, in late August 2017 and Hurricane Irma in Florida, in early September 2017. While the annual hurricane season is predictable, the location, timing and severity of individual hurricane events are largely unpredictable. Due to the unpredictability of the hurricanes, these can be considered as exogenous shocks, as they have been widely used in the finance literature (see for example, Rehse et al. 2019; Schüwer, Lambert and Noth 2019; Cortés and Strahan 2017; Dessaint and Matray 2017).

Hurricane Harvey and Hurricane Irma generated expectations of credit losses. For example, in October 2017, DoubleLine, Alliance Bernstein and other top mortgage credit buyers asked to remove natural catastrophe risk from credit-risk transfer notes after watching the market quiver in the wake of Hurricane Harvey and Hurricane Irma that followed. Accordingly, the Association of Mortgage Investors, in a letter sent to CRT executives at Fannie Mae and Freddie Mac, and the FHFA, recommended that Fannie Mae and Freddie Mac strip catastrophe risk from their CRT bonds or risk the “longevity” of the capital currently supporting the market (Yoon 2017). Thus, these hurricanes provide a natural experiment to study stress in the market for credit risk.

First, I use a difference-in-difference strategy to measure the market reaction to the hurricanes reflected on the prices of CRTs with different exposures to default. CRTs differ in the seniority of claims of credit losses, and the loan-to-value (LTV) ratio and geographical composition of their reference pool. These heterogeneities generate differences in exposure to the mortgage defaults caused by Hurricanes Harvey and Irma. The hurricanes were unexpected events. Thus, before the hurricanes arrive exaggerating credit risk, I find similar behavior across CRTs with different exposure to default risk. Once the risk appears I measure the effects on CRT prices in the secondary market.

The difference-in-difference results show that expectations of credit losses caused significant increases in the price of credit risk for those securities more exposed to the risk. The expectations of credit losses affected only CRT securities with subordinated claims to losses, and even more these CRTs with relatively larger geographical exposure to the areas hit by the hurricanes. I show that the results are not driven by increased liquidity risk.

In the second part of the chapter, I use the previous results to calibrate a credit model. I model the risky CRT tranches as risky mortgages. Consistent with the CRT price shock from the hurricanes, I derive the expectations of default. Finally, I estimate the time series of market implied mortgage rates and implied guarantee fees (g-fees) in the absence of GSEs, that would have applied given historical default rates.

This study is one of the first to estimate the pricing of credit risk based on investors' perceptions of the riskiness of mortgage lending by the GSEs. The estimations of the market implied mortgage rates during a credit shock contribute to the growing literature that studies the effects of a housing finance policy reform with limited role for the GSE mortgage guarantees (e.g. Elenev, Landvoigt and Van Nieuwerburgh 2016; Gete and Zecchetto 2018; Jeske, Krueger and Mitman 2013) and more broadly the literature that studies the macroeconomic effects of credit risk (e.g. Campbell and Cocco 2015; Garriga and Hedlund 2020).

The rest of the chapter is organized as follows: Section 3.3 summarizes the related literature. Section 3.4 provides the background of CRT transactions and describes the CRT debt security structure. Section 3.5 describes the data. Section 3.6 presents the diff-in-diff analysis. Section 3.7 presents the credit risk model, calibration and results. Section 3.8 concludes.

3.2 Introducción

El mercado hipotecario en los Estados Unidos ha estado en el centro de la crisis financiera de 2007-2009, ya que el sistema hipotecario estaba luchando para hacer frente a los impagos masivos de las hipotecas. Hasta el 1,5% de las hipotecas iniciaron procesos de ejecución hipotecaria en el pico de la crisis, mientras que el promedio histórico de 1990 a 2006 fue del 0,4% (Corbae y Quintin 2015). Las empresas patrocinadas por el gobierno (GSE), Fannie Mae y Freddie Mac, que garantizaban los pagos hipotecarios de préstamos titulizados en valores respaldados por hipotecas, sufrieron dificultades financieras. Esto llevó a su tutela bajo la Agencia Federal de Financiamiento de la Vivienda (FHFA) en septiembre de 2008. Al comienzo de su tutela, las GSE tenían o garantizaban alrededor de \$ 5.2 billones de deuda hipotecaria. En efecto, durante los últimos doce años, los contribuyentes estadounidenses han estado respaldando casi todas

las hipotecas titulizadas a través de las GSE.

La mayoría de las propuestas para reformar el sistema de financiación de la vivienda sugirieron transferir el riesgo a los mercados de capital, mediante un uso extendido de las transferencias de riesgo crediticio (CRT) en que Fannie Mae y Freddie Mac fueron pioneros en 2013 (Levitin y Wachter 2020).

Los CRT son valores estructurados con múltiples tramos que clasifican las pérdidas en caso de incumplimiento de las hipotecas. Su rendimiento está vinculado al rendimiento crediticio de los conjuntos de hipotecas que subyacen en los valores respaldados por hipotecas de agencias (MBS). La Agencia Federal de Financiamiento de la Vivienda (FHFA) pidió a Fannie Mae y Freddie Mac que usaran los CRT para transferir gran parte de su riesgo crediticio a inversores institucionales.

Entre 2013 y 2018 Fannie Mae y Freddie Mac transfirieron una parte del riesgo crediticio asociado con 2,8 billones de dólares de saldo de capital impago; con un riesgo en vigor combinado de alrededor de 91 mil millones de dólares (3.3% del saldo de capital impago). En 2018 el 73% de las hipotecas unifamiliares adquiridas por las GSE estaban destinadas a CRT.

Una cuestión política clave para un sistema reformado es cómo reaccionará el capital privado durante un período de tensión en el mercado. En términos más generales, la mayoría de las políticas de reforma proponen una reducción drástica del tamaño de las GSE. Tal reforma requerirá cambios drásticos en las tasas hipotecarias. En un mercado hipotecario sin las GSE, ¿Cuáles serían las implicaciones del estrés del mercado en las tasas hipotecarias? ¿Cómo se comportaría el mercado hipotecario durante el ciclo económico? Este capítulo tiene como objetivo proporcionar respuestas a estas preguntas.

Exploro el momento del huracán Harvey en Houston, Texas, a fines de agosto de 2017, y el huracán Irma en Florida, a principios de septiembre de 2017. Si bien la temporada anual de huracanes es predecible, la ubicación, el momento y la gravedad de los eventos de huracanes individuales son en gran medida impredecibles. Debido a la imprevisibilidad de los huracanes, estos pueden considerarse choques exógenos, y así han sido ampliamente utilizados en la literatura financiera (ver, por ejemplo, Rehse y col. 2019; Schüwer, Lambert y Noth 2019; Cortés y Strahan 2017; Dessaint y Matray 2017).

El huracán Harvey y el huracán Irma generaron expectativas de pérdidas crediticias. Por ejemplo, en octubre de 2017, DoubleLine, Alliance Bernstein y otros importantes compradores de créditos hipotecarios pidieron eliminar el riesgo de catástrofe natural de las notas de transferencia de riesgo crediticio después de ver cómo el mercado temblaba a raíz del huracán Harvey y el huracán Irma que siguieron. En consecuencia, la Asociación de Inversores Hipotecarios, en

una carta enviada a los ejecutivos de CRT en Fannie Mae y Freddie Mac, y la FHFA, recomendó que Fannie Mae y Freddie Mac eliminaran el riesgo de catástrofe de sus bonos de CRT o arriesgaran la "longevidad" del capital actual apoyando al mercado (Yoon 2017). Por lo tanto, estos huracanes proporcionan un experimento natural para estudiar el estrés en el mercado por riesgo crediticio.

Primero, utilizo una estrategia de diferencias en diferencias para medir la reacción del mercado a los huracanes reflejada en los precios de los CRT con diferentes exposiciones al incumplimiento. Los CRT difieren en la antigüedad de las reclamaciones por pérdidas crediticias y la relación préstamo-valor (LTV) y la composición geográfica de su grupo de referencia. Estas heterogeneidades generan diferencias en la exposición a los incumplimientos hipotecarios provocados por los huracanes Harvey e Irma. Los huracanes fueron eventos inesperados. Por lo tanto, antes de la llegada de los huracanes exagerando el riesgo crediticio, encuentro un comportamiento similar en los CRT con diferente exposición al riesgo de incumplimiento. Una vez que aparece el riesgo, mido los efectos sobre los precios de CRT en el mercado secundario.

Los resultados de diferencias en diferencias muestran que las expectativas de pérdidas crediticias causaron aumentos significativos en el precio del riesgo crediticio para aquellos valores más expuestos al riesgo. Las expectativas de pérdidas crediticias afectaron solo a los valores CRT con reclamos subordinados a pérdidas, y aún más a estos CRT con exposición geográfica relativamente mayor a las áreas golpeadas por los huracanes. Demuestro que los resultados no están impulsados por un mayor riesgo de liquidez.

En la segunda parte del capítulo, utilizo los resultados anteriores para calibrar un modelo de crédito. Modelizo los tramos riesgosos de CRT como hipotecas de riesgo. De acuerdo con el impacto de los precios de CRT por los huracanes, derivé las expectativas de incumplimiento. Finalmente, estimo la serie de tiempo de las tasas hipotecarias implícitas del mercado y las tarifas de garantía implícitas (tarifas g) en ausencia de GSE, que se habrían aplicado dadas las tasas históricas de incumplimiento.

Este estudio es uno de los primeros en estimar el precio del riesgo crediticio con base en las percepciones de los inversores sobre el riesgo de los préstamos hipotecarios por parte de las GSE. Las estimaciones de las tasas hipotecarias implícitas del mercado durante un shock crediticio contribuyen a la creciente literatura que estudia los efectos de una reforma de la política de financiación de la vivienda con un papel limitado para las garantías hipotecarias GSE (por ejemplo, Elenev, Landvoigt y Van Nieuwerburgh 2016; Gete y Zecchetto 2018; Jeske, Krueger y Mitman 2013) y más ampliamente la literatura que estudia los efectos macroeconómicos del riesgo crediticio (por ejemplo, Campbell y Cocco 2015; Garriga y Hedlund 2020).

3.3 Literature Review

3.3.1 Housing finance reform without GSEs

This chapter contributes to the literature that studies the effects of a housing finance policy reform with limited role of the mortgage guarantees by GSEs. Elenev, Landvoigt, and Van Nieuwerburgh (2016) evaluate different policy proposals with a new model of the mortgage market that focuses on the role of the financial sector and the government. The authors find that, while mortgage guarantees enhance the stable provision of mortgage credit especially in crises, they induce moral hazard by the financial sector.

Gete and Zecchetto (2018) study the distributional implications of the removal of the credit-risk guarantees by the GSEs, and they find that the mortgage spreads increase, housing holdings become more concentrated, and the removal benefits high-income households, while hurting low- and mid-income households. Jeske, Krueger, and Mitman 2013 examine the distributional and macroeconomic effects of the government bailout guarantees for the GSEs. The authors find that the government bailout guarantees is a policy that hurts low-income households: eliminating it causes a decrease in mortgage origination, but has does not affect significantly the foreclosure rates or housing investment.

Frame, Wall, and White (2013) highlight the necessity of the housing finance reform in the U.S. by laying out critical assessments of various types of policy proposals, finding very little consensus on the role and level of involvement of the federal government. Glaeser and Gyourko (2008) and Levitin and Wachter (2013) provide thorough examinations of the federal housing policy in light of the 2008 Financial Crisis and the housing bubble that preceded it. Passmore, Sparks, and Ingpen (2002) and McKenzie (2002) estimate the implicit subsidy from the GSEs. Hurst et al. (2016) show that, so far, the administrative rates on GSE mortgages do not account for regional variation in predictable default risk. This study can inform the debate about housing finance reform and the role of the GSEs.

3.3.2 Evaluation of Credit Risk Transfers

This chapter contributes to the recent literature that studies the effectiveness of the Credit Risk Transfer programs. Finkelstein, Strzodka, and Vickery (2018) evaluate and discuss the performance of the CRT notes. Wachter (Forthcoming) studies how would the CRT market have behaved, if it was in place during the housing bubble years. Layton (2020) studies the effectiveness of CRTs in achieving two vary important goals: reduce systemic risk and lower

the degree of taxpayer exposure to GSE risk. He concludes: "CRT may be the single biggest reform of the GSE system in the last decade in that it has fundamentally changed how the two companies manage the credit risk of their immense mortgage guarantee books of business." (Layton 2020:15).

3.3.3 Financial implications of natural disasters

Disasters of the magnitude of hurricane Harvey happen more often and with larger intensity due to the ambiguous global warming. It is more important than ever to understand their consequences for the affected households and financial institutions, as increasing systemic risk from natural disasters is a threat to the stability of the financial system. Cortés and Strahan 2017 show that multi-market banks reallocate lending from unaffected areas to areas hit by a natural disaster. Ouazad and Kahn 2019 find a substantial increase in the securitization volume and adverse selection of mortgages below the conforming loan limit after a billion-dollar natural disaster. Using a simulation, the authors find that the GSEs may act as implicit insurers for the increasing climate risk, as mortgage lenders may transfer default risk due to floods to the GSEs.

By exploiting geographical heterogeneity due to hurricanes, recent papers study the hurricanes' effects on the financial and housing markets. Schüwer, Lambert, and Noth (2019) study the effects of Hurricane Katrina in 2005 on bank stability, focusing on asset allocation and lending, and how characteristics of the local banking system relate to local economic developments after the natural disaster. Rehse et al. 2019 find that Real Estate Investment Trusts more exposed to the evacuation zone of New York City prior to the landfall of Hurricane Sandy in 2012 experienced relatively less liquidity in trading. Lanfear, Lioui and Siebert 2019) highlight the relevance of climate risk for stock returns and liquidity, by studying North Atlantic hurricane landfalls over the period 1990 to 2017. Ortega and Taspinar (2018) examine the effects of hurricane Sandy on local housing markets in New York City. Dessaint and Matray (2017) show that managers perception of disaster risk becomes more salient temporarily after the hurricanes' landfall.

Another part of literature studies the effects of natural disasters on the credit markets. Morse (2011) shows that high-interest credit mitigates a significant part of the foreclosures in California after a natural disaster. Berg and Schrader (2012) show that volcanic eruptions in Ecuador increase credit demand, but also restrict lending for borrowers who do not have a previous relationship with the lending institution. Chavaz (2016) shows that the disastrous 2005 hurricane season in the U.S. caused lenders with concentrated exposure to the affected areas

to increase lending and sell a higher share of the new mortgages into the secondary market, compared to more geographically diversified lenders. Similarly, Cortés (2014) highlights the important role that local lenders play in the recovery after a natural disaster. This chapter complements the growing literature that studies the financial implications of natural disasters, by studying the pricing of credit risk in mortgage markets after catastrophic hurricanes destroy parts of the U.S. coast.

3.3.4 Mortgage risk pricing during the economic cycles

This chapter also expands the literature on mortgage risk pricing during the economic cycles. Levitin, Lin and Wachter (2019) find a decline in credit spreads on mortgages underlying private-label mortgage-backed securities during the years prior to the 2008 financial crisis, controlling for loan and borrower characteristics. The authors conclude that the private-label securitization failed to price the increasing credit risk.

Consistent with these results, Justiniano, Primiceri and Tambalotti (2017) show that delinquency rates started to increase for loans originated after mid 2003, while at the same time mortgage rates disconnected from Treasury yields and the price of credit decreased. Rajan, Seru and Vig (2015) show that mortgage rates during the years prior to the 2008 financial crisis only reflected variables that are reported to investors of the securitized products and dismissed other credit-relevant information. This chapter contributes to this literature by exploiting a period of unexpected market stress (due to the hurricanes) during a period of economic growth in the U.S.

Finally, the chapter is related to the growing literature that studies macroeconomic effects of credit risk (see for example, Campbell and Cocco 2015; Kim and Wang 2016; and Garriga and Hedlund 2020). Related to this literature, this study focuses on modeling the lender preferences and uses the market implied mortgage rates to solve the credit risk model.

3.4 Overview of Credit Risk Transfers

3.4.1 Background

The GSEs have historically been exposed to significant mortgage credit risk, mainly because they provide a credit guarantee of timely payment of principal and interest to investors of the agency mortgage-backed securities (MBS) they issue. The 2008 financial crisis resulted in

high mortgage credit losses for the GSEs, which led to their conservatorship by the FHFA in September 2008.²⁶ Under this conservatorship, the MBSs that the GSEs issue are effectively guaranteed by the federal government. The guarantee exposes the government and the U.S. taxpayers to the risk of significant mortgage defaults.

Directed by the FHFA, the GSEs developed credit risk transfer (CRT) transactions, and brought them to the market mid 2013. These transactions are loss sharing agreements with private investors who would share the credit risk on mortgage loans underlying agency MBSs. The CRT debt securities are Freddie Mac's Structured Agency Credit Risk (STACR) securities and Fannie Mae's Connecticut Avenue Securities (CAS). The STACR and CAS debt securities have been the most widely used from the credit risk mitigation instruments, accounting for 77% of the risk in force shed from the GSEs' balance sheets.²⁷ CRT transactions currently are being executed in a fully functioning liquid market, and have gained a broad investor base. Since their inception CRTs provided GSEs with loss protection on more than \$1.6 trillion of mortgage loans.

The novel CRT securities have shown promising performance in their first four years in the market (CBO 2017; FHFA 2017). Previously, the Federal Home Loan Banks' mortgage purchase programs used risk-sharing agreements, especially popular in the early 2000s, that had mechanisms similar to the CRT securities (Frame 2003). The use of CRTs is likely to be expanded, as other financial institutions, such as JPMorgan Chase & Co., are exploring CRT issuance as a mechanism for regulatory capital relief (Bloomberg 2019b).

3.4.2 CRT structure

The CRTs are notes with final maturity 10 or 12.5 years that offer to investors rights to cashflows from a reference pool of mortgages that individually may underlie recently securitized agency MBSs. The notes pay monthly a share of the mortgage principal to the investors as this gets repaid, plus interest. By contrast, in a traditional MBS structure, there is true sale of a specific pool of mortgages to move specific assets off-balance sheet. To date, the CRTs have referenced 30-year fixed rate mortgages, which represent the majority of mortgages securitized into MBSs. The principal balance of a CRT note is a percentage of the total outstanding principal balance

²⁶At the time of the 2008 financial crisis the GSEs were managing credit risk by charging guarantee fees to the MBS investors, by requiring private mortgage insurance or additional credit enhancement for mortgages with loan-to-value ratios exceeding 80%, by setting minimum underwriting standards, by requiring representations and warranties from the loan sellers, and by keeping equity capital as additional buffer against insolvency. These credit risk management tools did not prevent the high mortgage losses during the 2008 financial crisis.

²⁷Alternative risk sharing mechanisms include risk sharing with mortgage originators, credit insurance and credit enhancement contracts.

of the reference pool. Each reference pool consists of around 139 million mortgages, with total unpaid principal of approximately \$30 billion at the time of issuance.

The mortgage reference pools have two characteristics that are key to the subsequent analysis. First, all reference pools are geographically diversified. They contain mortgages on houses in all U.S. States. The highest concentration is commonly in the States of California, Texas, Florida, Illinois, Georgia or Virginia. There is variation within the share of principal balance in each State across CRTs. Second, the reference pools are split into two groups: high or low LTV. The high LTV pools contain exclusively mortgage loans with LTV ratios higher than 80% and up to 97%. The low LTV pools contain exclusively mortgage loan with LTV ratios between 60% and 80%. The first CRT contracts were based on a fixed severity schedule, that is, the recovery value of the foreclosed houses were calculated based on a step function. The fixed severity schedule expedited the procedure of calculating the losses, without waiting for the formal foreclosure processes. From the second quarter of 2015 the GSEs started issuing CRTs based on actual severity.

Figure 3.1 shows a sample CRT transaction. The outstanding principal balance at issuance is divided into tranches with different levels of seniority. The most senior tranche is retained entirely by the GSEs. Next in seniority are typically two or three “mezzanine” tranches, and immediately lower in seniority is the subordinate tranche, which are sold to investors. The most subordinate tranche, or “first loss”, was retained by the GSEs in the early CRT transactions, but it is sold to investors after 2016. A typical allocation of the outstanding principal balance is 95.0%-96.0% to the most senior tranche retained by the GSEs, 3.5%-4.0% to the mezzanine tranches, and 0.5%-1.0% to the subordinate and first loss tranches. Higher percentage of losses is allocated to the subordinated tranches when the first loss is sold to investors. The GSEs also retain a vertical slice of each of the tranches sold to investors, as a mechanism to reduce the GSEs moral hazard in the selection of mortgages.

Appendix C1 contains detailed calculations of the CRT cash flows. The cash flows from the scheduled principal payments (mortgage repayments) and unscheduled principal payments (early repayments) from the borrowers on mortgages in the reference pool are used to repay the most senior tranche owned by investors still outstanding at any given point. The principal balance of the CRT notes is reduced by the amount of these payments. Once the principal balance of most senior tranche outstanding is eliminated, the next tranche in seniority starts getting repaid and having its principal balance reduced by the scheduled and unscheduled principal payments. The losses on mortgages in the reference pool are used to reduce the principal balance of the most subordinate tranche outstanding. Once the principal balance of most subordinate tranche outstanding is eliminated, the next most subordinate tranche starts

having its principal balance reduced by the mortgage losses. Figure C1 shows the cashflows of a CRT deal for the different tranches.

The monthly interest paid to the investors is a floating rate on the outstanding principal balance equal to one month U.S. Dollar LIBOR plus a “floating spread” determined at the time of the primary market issuance. The floating spread is higher for the subordinate tranches. For example to date, the subordinate tranche of Fannie Mae’s CRTs paid a spread of 8 percentage points on average, whereas the mezzanine tranches paid a spread of 3 percentage points on average. The floating spreads are generally set to ensure that the CRT notes are priced at par, that is, investors pay \$1 for every \$1 of principal of the CRT note. Figure C2 shows the historical spreads of the CRTs in the primary market. The credit spreads at issuance on the higher rated CRT mezzanine tranches (M-1) seem to be correlated with the corporate BBB index, while the credit spreads at issuance on the lower rated CRT mezzanine tranches (M-2) seem to be correlated with the high yield Credit Default Swap Index (FHFA 2017: 13-14).

The trading of CRTs provides information about what private capital markets would charge for sharing the credit risk generated by the credit guarantee business of the GSEs (Wachter Forthcoming). The CRT performance is directly linked to the risk of the default of the underlying mortgages. Importantly, Freddie Mac and Fannie Mae made available to investors the characteristics and performance over time of the underlying mortgage pools as well as of the individual loans. Investors have complete information of the underlying securitized credit, in a way that is standardized and transparent. Thus, CRT pricing identifies the investors’ perceptions of the riskiness of mortgage lending based on the GSEs’ portfolios. Knowledge of credit conditions informs the market perception of credit risk, which is indicated in the market pricing of CRTs.

3.5 Data

I assemble a unique database of CRTs, by combining information from five data sources. First, I collect data about the mortgages in the reference pool for the CRTs from the web pages of the GSEs (Fannie Mae 2020; Freddie Mac 2020). The GSEs make public the features and performance over time of the mortgage loans in the reference pool of CRTs. Specifically, for all CRTs issued up to February 2018, I collect the LTV ratios of the mortgages in the reference pool of the securities, the geographical composition of the reference pools, and the delinquencies over time of the CRT deals. Table 3.1 presents the distribution of CRTs in the sample based on risk characteristics. There are in total 171 CRT in the sample, which is the universe of CRTs

from the time of the first issuance up to the month before the hurricanes I study. I restricted the sample before the hurricanes, so the results are not affected by new issuances.

Second, I build a database of all CRT issuances from Bloomberg, including issuance dates, the tranches determining the seniority of credit protection and the ones retained by the GSEs, the original principal balance per tranche, and the bpsater spread paid by each tranche.

Third, I collect the time series of prices and yields in the secondary market of CRTs from Thomson Reuters Eikon.²⁸ I also use the 1-month US Dollar LIBOR benchmark from Thomson Reuters Eikon, to calculate the spread over LIBOR I use in the analysis. Table C1 shows the process of merging the datasets. Table 3.2 shows the summary statistics of the daily spreads and CRT characteristics used in the diff-in-diff analysis.

Fourth, for the model estimation, I use the stressed default rates for various mortgage characteristics from Davis et al. (2019). Davis et al. (2019) provide a detailed account of the history of default risk for newly originated home purchase loans since the 1990s. Finally, I use the loan-level data from Freddie Mac to merge with default probabilities.

Moreover, I obtain the time series of actual mortgage rates on 30-year fixed rate mortgages from 1994 to 2018 from Freddie Mac Research (2020). I obtain the time series of the effective single-family guarantee fees from 1994 to 2018 from the Federal Housing Finance Agency: Monthly Interest rate Survey All Homes, Fixed-Rate Mortgages - Table 20 (FHFA 2020).

3.6 Empirical Analysis

Since the beginning of the CRT market in 2013, there were no major shocks to credit risk, or to expectations of credit risk, until August 2017, when Hurricane Harvey was approaching the U.S. coast. Harvey was soon followed by Hurricane Irma in September 2017. These two hurricanes caused some of the largest disasters of all time. Among all U.S. hurricanes, Harvey and Irma rank in the top five of the costliest storms on record, with damages of approximately \$125 billion and \$50 billion respectively (National Hurricane Center 2018). Mainly the metropolitan area of Houston, Texas was damaged by Harvey and the southern part of Florida was damaged by Irma. The storms and rainfalls impacted thousands of households and led to a considerable surge in mortgage delinquencies.

While the Atlantic hurricane season runs from June to November, the exact timing of the hurricanes and the exact location of the landfalls were largely unexpected. The unexpected

²⁸We cross-checked the prices with data from TRACE.

nature of the hurricanes, along with their strong salience and impact, makes them a suitable exogenous shock to study local housing and mortgage markets. Various papers, such as Cortés and Strahan (2017), Schüwer, Lambert and Noth (2019) and Rehse et al. (2019) use hurricanes as exogenous shocks to local markets.

The analysis of the CRT daily pricing in the secondary market is based on a difference-in-difference methodology. The treatment group are those CRT notes with the highest geographical exposure to the hurricane-affected areas, and the control group those with the lowest geographical exposure. As I explained earlier, the investors have available all information about the characteristics of mortgages underlying the CRTs. Importantly, the GSEs published supplementary disclosures about the loans in the CRT mortgage pools that are in the hurricane affected areas, days after the hurricanes' landfalls. Specifically, the exposure variable is the share of unpaid principal balance in the CRT mortgage pool that is located in one of the counties listed by the Federal Emergency Management Agency as a major disaster area and in which individual assistance to homeowners is authorized as a result of Hurricane Harvey or Irma. The identification assumption is that, prior to the 2017 hurricanes, the geographical exposure of the CRT mortgage pools to counties in major disaster areas was not correlated with the perceived credit risk of the CRT notes.

First, I show that the geographical distribution of the CRT mortgage pools was a determining factor for the share of delinquencies when the hurricanes hit. Figure 3.2 shows that there was an unprecedented, sharp increase in the delinquencies of more than 120 days in the reference pool of CRTs following the hurricanes' landfalls in the U.S. coast. Importantly, while all CRT pools are geographically diversified and include mortgages from all U.S. states, those CRTs that had a higher share of mortgages in the hurricane damaged areas, experienced a substantially higher share of delinquencies. The two hurricanes in 2017 were a relevant, exogenous event for mortgage credit risk.

Second, I show that the riskiness of the mortgage pools based on the LTV ratios was also a factor that contributed to more delinquencies. Figure 3.3 shows that the share of delinquencies of more than 120 days in the CRT underlying mortgage pools of high LTV ratios (81-97%), increased substantially more compared to the mortgage pools of low LTV ratios (60-80%). This fact is consistent with the LTV ratio being a determining factor for credit risk.

Eventually the relief options offered to affected mortgagors helped substantially not to translate the delinquencies to foreclosures (see for example Bakel 2017; Freddie Mac 2017a, 2017b).²⁹ However, *ex-ante*, there was considerable uncertainty about the effects of the hurricanes on the

²⁹See Foote, Gerardi and Willen (2008) for an assessment of foreclosure-reduction policies.

CRT performance. The warnings about Hurricane Harvey forming in the Atlantic and approaching Texas, and the news of the landfall in the U.S. coast, the CRT investors created expectations of credit losses.

Specifically, the investors of the junior tranches of CRTs who are the first in order to take on the losses, reacted by demanding higher spreads, as Figure 3.4 shows. The top panel of Figure 3.4 shows that after at least six months of constant drop in spreads, there was a sharp increase of one percentage point on average at the time of the landfall of hurricane Harvey, towards the end of August 2017. In other words, the price of the risky CRTs fell considerable with the landfall of Hurricane Harvey. The yield spreads are the compensation the investors demand for taking on credit risk. The investors kept the spreads at high levels, as the landfall of Hurricane Irma at the beginning of September 2017 followed. The spreads reverted back to the pre-hurricane trend in December 2017.

The average spreads show a strong effect of the first landfall, and minimal announcement effect. Interestingly, there is a strong announcement effect for the junior CRT tranches that were in the market for less than six months. These are arguably the CRT notes with the highest risk, since, compared to other CRTs, they have the maximum time remaining until their final maturity. The bottom panel of Figure 3.4 shows that investors reacted to the first warnings about Hurricane Harvey forming in the Atlantic, by demanding higher spreads for taking on credit risk. For these young CRTs, the spreads took longer to recover their pre-hurricane levels. The control variables in the specification, such as the issuance year, account for such differences.

Figure 3.5 shows that the spreads for CRTs that were more geographically exposed to the state of Texas reacted more than the ones for less exposed CRTs. Ex-ante the investors did not know exactly the extend of the damages in each CRT pool. However, they had information about the geographical concentration of the mortgage loans' principal balance within the U.S. Although the concentration for Texas and Florida is fairly similar in many CRT pools, the CRTs I plot in Figure 3.5 show that there is an effect of geographical exposure on spreads. These CRTs are almost identical in all risk dimensions, but have the largest difference in the geographical concentration in Texas. The CRT with high concentration in Texas showed larger increase in the spreads. Moreover, the parallel trends assumption for the diff-in-diff identification is satisfied. The spreads of the two CRTs show similar dynamics before the first landfall.

Figure 3.6 plots the spreads of the junior CRTs by the two groups of high and low LTV. The trends were broadly parallel, before the news about Hurricane Harvey. As expected, the high-LTV CRTs have on average higher spreads, due to higher credit risk. At the time of the first news about Hurricane Harvey there was a sharp increase in the spread of both groups,

with the high LTV group increasing even more. The expectations of credit losses were larger for the more risky CRTs based on the LTVs.

Consistent with Dessaint and Matray (2017) the investors reacted to credit risk as it became more salient. Based on the previous figures, the reaction lasted up to about eight weeks and subsided afterwards, as the investors revised their expectations. Moreover, the daily announcements by the GSEs and the government of the disaster assistance programs likely contributed in the revision of the initial beliefs. Next, I formally present the specification.

3.6.1 Specification

I use a difference-in-difference specification with panel data of daily CRT spreads. The “treatment” is the first trading date after the landfall in the U.S. coast of Hurricane Irma on September 11th 2017. This specification aims to capture the combined effects of the two hurricanes, since Hurricane Irma hit the U.S. two weeks after Hurricane Harvey. I estimate the effects of the hurricanes on the daily spreads of CRTs with heterogeneous geographical exposure to the hurricane-hit areas.

The specification is

$$S_{i,t} = \beta_0 + \beta_1 T_t + \beta_2 E_i + \beta_3 T_t E_i + a_i + C_i + D_t + u_{i,t}, \quad (3.1)$$

where i indexes securities and t days. $S_{i,t}$ is the spread of security i at time t calculated as the yield to maturity minus the one month U.S. Dollar LIBOR. T_t is the treatment variable that takes the value of 1 for t on and after the first trading date after Hurricane Irma’s landfall, and zero otherwise. E_i is the percentage of CRT i unpaid principal balance geographically exposed to Hurricane Harvey and Hurricane Irma combined, as reported by the GSEs. The variable of interest is the interaction $T_t E_i$. The coefficient β_3 measures how much an additional percentage point of exposure to the hurricanes is related to a change in spreads, after the hurricanes hit.

a_i are issuance year dummies to capture differences in the spread of the issuance year cohorts of CRTs and different time to maturity. The specification includes cross-sectional controls C_i , which are the better spread to account for the riskiness of the security, and an indicator for the issuer, Fannie Mae or Freddie Mac. Time series controls D_t are included to isolate the effect of the timing of the hurricanes from other potential economic influences happening at the same time. The time series controls are the 10-year treasury rates, in line with the original time to maturity of the CRTs, and 2-year treasury rates to reflect shorter maturities. I estimate the

model for time windows of 2 to 8 weeks before and after the treatment date.

CRTs differ substantially in their exposure to credit risk based on the LTV ratios in the mortgage reference pool, and the claims to losses depending on tranche subordination. To isolate the effect of the hurricanes based on the geographical exposure, I perform the diff-in-diff analysis on different samples, that is, for high and low LTVs, and for subordinated and mezzanine tranches. In the next section I specifically turn the focus on the riskiest sample, junior CRTs with high LTVs, to develop a credit risk model.

Table 3.2 presents summary statistics of the key variables for the subordinated CRTs. The high-LTV CRTs have higher issuer spreads (spreads at issuance) and higher yield spreads in the secondary market, consistent with higher credit risk.

Table 3.3 presents the estimates of specification (3.1) for the subordinated tranches and different LTVs. Spreads increase significantly after the hurricanes for CRTs with larger exposure to the hurricanes for time windows between 2 and 8 weeks after Hurricane Irma's landfall. To put the results into perspective, three weeks after the landfalls the yield spreads of the junior CRT tranche with high LTV and the maximum exposure to the hurricane affected areas increase on average by 0.7 percentage points more compared to the junior CRT tranche with the minimum exposure.³⁰

To address concerns that the results might be affected by liquidity risk, I control in the previous specification for the daily trading volume of the junior CRTs.³¹ Table 3.4 shows that the results remain broadly unchanged compared to the baseline results in Table 3.3. Any changes in trading volume are not driving the changes in credit spreads. Moreover, qualitative evidence from the overall transaction volume (Figure C3) does not show any sign of illiquidity at the time of the hurricanes.

The results of this analysis provide a baseline of the pricing of credit risk by the markets during a period of market stress. Overall, I find that credit risk exposure increases the price of credit risk in CRTs during a period of market stress. The magnitude of losses in the study only affected the securities with the junior claim to losses.

Table 3.5 shows that the mezzanine tranches reacted very little to the landfall, and the geographical exposure to the hurricanes did not matter for the jump in spreads. The small reaction of the mezzanine tranches to increased credit risk is in line with the credit protection of the CRT structure. The junior tranches would need to absorb on average 0.5% to 1.0% of

³⁰ 9.44 (from Table 3.3) \times $(9.30-2.16)$ (from Table 3.2) = 67.40 basis points.

³¹Due to data limitations, I do not have available the bid-ask spreads for the CRTs. Specifically, debt securities issued by the GSEs are not eligible for reporting in Trade Reporting and Compliance Engine (TRACE).

losses in the underlying principal balance, before the mezzanine tranches begin to absorb losses. In the extreme worst case, 9.3% of the mortgages in the CRT pools would be in areas destroyed by the hurricanes and 20% of them would default. Assuming they would suffer losses severity of 10% to 40% of principal, the worst case scenario would result in total losses of 0.19% to 0.74%. This is still below the 1.0%, and in the worst case slightly above the 0.5% credit enhancement for the mezzanine tranches.

Being local shocks, the hurricanes did not wipe out substantial value from the CRTs, since the underlying mortgage pools are well diversified. However, the CRT market priced the ex-ante credit risk at the time of the landfalls of the catastrophic hurricanes Harvey and Irma.

3.7 Credit Supply

In this section I estimate a credit risk model to be consistent with the previous evidence, I simulate the latest cycle in the U.S. housing market and derive implications for mortgage markets. Specifically, I simulate the experience of mortgage loan defaults in the last 25 years. Figure 3.7 shows the expansion period that preceded the Great Recession of 2007-2009 when real house prices experienced positive growth, the substantial drop in prices from 2007 up to 2011 to 2012, and the period of recovery and expansion that came after, which was followed by steady rise in real prices. One important consequence of the housing market cycle, was the large variation in the default rates of mortgage loans, that are also shown in Figure 3.7.

I map expectations of mortgage loan defaults that are at the levels of the realized defaults during the peak of the crisis onto market implied mortgage rates. I solve endogenously for the borrowers' probability of default and recovery rate to be consistent with the market implied mortgage rate from the CRT private market before and after the hurricanes. Then, I model the issuance of new mortgages by mortgage lenders, in a world without credit guarantees for the last 25 years.

3.7.1 Lenders

Lenders are risk neutral and compete loan by loan. Lenders are financed through deposits at cost r_d ; they also face origination costs r_w per unit of mortgage they issue. Positive origination costs $r_w > 0$, ensure a positive mortgage spread over the deposit rate for households with zero-default risk. Lenders will originate any mortgage that in expectation allows them to cover their cost of funds. Lenders take into account that households may default on their mortgages. If

the borrower defaults then the lender receives a fraction $\gamma < 1$ of the house value, called the *recovery rate*.

Lenders price mortgages, in the absence of GSE credit guarantees, according to the lenders' zero-profit condition:

$$(1 + r_d + r_w)L = (1 - \pi)(1 + r_m)L + \pi\gamma P_h, \quad (3.2)$$

where L is the original loan amount, π is the expected probability of the borrower's default, r_m is the interest rate charged on the mortgage, called the *mortgage rate*, and P_h is the house price. Dividing both sides of (3.2) by L , this simplifies to:

$$1 + r_d + r_w = (1 - \pi)(1 + r_m) + \frac{\pi\gamma}{ltv}, \quad (3.3)$$

where $ltv = \frac{L}{P_h}$ is the loan-to-value ratio.

Lastly, I obtain the market implied guarantee fees r_g from:

$$r_g = r_m - r_d - r_w. \quad (3.4)$$

That is, the market implied guarantee fees, are the excess of the mortgage rate over the cost of capital and origination cost for the bank. The guarantee fee is the part of the mortgage rate that compensates for the credit risk.

3.7.2 Calibration

I set the following values to the exogenous parameters: r_d is the five-year certificate of deposits rate. In 2017 the average five-year CD rate was 0.85%. I set the mortgage origination cost $r_w = 1.18\%$, which was the average cost in 2017 (FHFA Monthly Interest Rate Survey, Table 20). I set the loan-to-value ratio ltv to be 82.3%, which is the average ratio for GSE guaranteed mortgages in 2017. This way the probabilities of default I estimate reflect the average borrower with average leverage.³²

I set the values for the mortgage rate r_m to be consistent with the previous empirical analysis. $r_m^{pre} = 7.52\%$ is the average spread over LIBOR in the secondary market for risky CRTs, right before the hurricanes' landfall. In theory, this is the rate that investors demand to be compensated for the credit risk they are taking on. I model the payment of risky CRTs,

³²It is widely shown that the risk of default increases with leverage (e.g. Schwartz and Torous 1993; Mayer, Pence and Sherlund 2009; Corradin 2014; Corbae and Quintin 2015).

consisting of the junior tranches of a mortgage pool, like a highly risky mortgage. $r_m^{post} = 8.47\%$ is the average spread over LIBOR in the secondary market for risky CRTs, 2-3 weeks after the hurricanes'landfall. Expectations of defaults rise with the news of the hurricanes'landfall. The mortgage rate post-hurricanes shows how much compensation investors demand to take on the increased credit risk. Table 3.6 summarizes the model parameters.

The endogenous parameters I want to estimate are the expected probability of default pre- and post-hurricanes, π^{pre} , π^{post} and the corresponding expected recovery rate γ^{pre} , γ^{post} . From the previous data I derive an estimate for the change in expectations. Following the hurricanes'landfall, the private market (the lenders in the case of the credit model) increase their expectations of default and at the same time expect that they will receive less from the foreclosed housed, due to more severe damages. I assume that the change in the expected recovery rate changes with the change in the expected default probability in the following way:

$$\gamma^{post} - \gamma^{pre} = -0.40(\pi^{post} - \pi^{pre}). \quad (3.5)$$

This equation comes from Freddie Mac's estimations of recovery rates for the CRTs based on fixed severity.

Within days after the landfalls, the GSEs published the estimated geographical exposure of the CRTs to areas in the hurricane-hit zones. The underlying mortgages of the risky CRTs were geographically exposed to the areas destroyed by the hurricanes up to 9.30%. I assume that 20% of the mortgages in the hurricane-hit neighborhoods are expected to default, or $20\% \times 9.30\% = 1.86\%$ of the mortgage pool. That is, following the hurricanes'landfall, the borrowers increase their expectations of default by 1.86%. $\pi^{post} - \pi^{pre} = 1.86\%$. From (3.5) the change in the expected recovery rate is $\gamma^{post} - \gamma^{pre} = (-0.40)1.86\% = -0.74\%$.

3.7.3 Results

In summary, I solve the lenders' zero-profit condition in (3.3) pre- and post- hurricanes by substituting the "mortgage rate" implied from the CRT secondary market. Based on the assumption about the jump in the expected probability of default and the drop in the expected recovery rate after the hurricanes, I solve for π^{pre} , π^{post} , γ^{pre} and γ^{post} . Table 3.7 contains the solution. The expected default probability before the hurricanes is $\pi^{pre} = 32.36\%$, and the expected recovery rate is $\gamma^{pre} = 74.53\%$. These rates are consistent with the data and are also within reasonable bounds of a risky mortgage (Davis et al. 2019). Post hurricanes the expectations change to $\pi^{post} = 34.22\%$, and the expected recovery rate is $\gamma^{post} = 73.78\%$.

I use the previous solutions as the baseline. Probability of default $\pi = 32.36\%$ corresponds to a recovery rate of $\gamma = 74.53\%$. Then I plug-in the model the probabilities of default of GSE guaranteed loans. The data are provided by Davis et al. (2019) that study comprehensively the evolution of default risk for newly originated home purchase loans since the 1990s. These probabilities of default correspond to the actual mortgage default experience during 2006-2007. They provide a benchmark for defaults during times of market stress.

Figure 3.8 shows the estimated market implied mortgage rates, in a world without GSE guarantees, and compares with the actual average interest rates on mortgages guaranteed by the GSEs. The market implied rates are much more volatile than the actual administrative rates. During the housing bubble of 2005-2006 and the beginning of the financial crisis in 2007 the market implied mortgage rates were at least one percentage point higher than the actual rates on GSE guaranteed mortgages. This was due to high probabilities of default that had been increasing since the beginning of the 2000s, and reached extreme levels higher than 20 percent in 2007.

After the crisis, the default probabilities, as well as the certificate of deposits rate dropped significantly. The GSEs did not adjust the mortgage rates as much, with the result that the actual mortgage rates were about 2 percentage points higher than the market implied rates during the decade that followed the financial crisis. Figure C4 shows the stressed probabilities of default, along with the 5-year CD rate. These are two important factors that determine the market implied mortgage rates in the model.

Moreover, I compare the pricing of CRTs implied by the market to the GSEs' pricing of credit risk, through the GSEs' g-fees. This comparison has important implications, since it can determine whether the pricing of credit risk by the GSEs is in line with the market perception of credit risk (Wachter Forthcoming). Figure 3.9 shows the estimated market implied g-fees and compares with the actual administrative g-fees on mortgages guaranteed by the GSEs. From this figure it is obvious that the setting of the administrative g-fees took little in account the prevailing credit risk in the mortgage market. The fees were set at about 0.25% from 1994 to 2009 and increased up to 0.6% thereafter. On the other hand, the market-implied g-fees ranged between 0.7% and 1.0% in the years 1994 to 2004, when they began increasing sharply and peaked at 2.5% in 2007. The market-implied g-fees fell in 2008 and have been close to zero thereafter, due to the presence of lower credit risk and also exceptionally low CD rates.

3.8 Conclusions

This chapter studies how the mortgage market would perform in a scenario without the GSE guarantees. First, I show how institutional investors' capital in mortgage markets would absorb credit risk, through the CRTs. The junior CRTs highly exposed to credit risk, react significantly in news of the landfall of Hurricane Harvey and Hurricane Irma. The landfalls generate expectations for higher probability of default and lower recovery rates in case of default. These expectations are demonstrated in the market for CRTs by a sudden increase in the credit spreads. The investors demand higher spreads to compensate for the higher risk.

Furthermore, this chapter estimates the market implied mortgage rates and guarantee fees in a world without the GSE guarantees, through the past quarter of a century. During this time the housing and mortgage markets experienced a boom and bust cycle. The model is calibrated by the reaction of CRT investors to the hurricanes. At the peak of the mortgage defaults in 2007, the actual g-fees were 2.25 percentage points lower than the ones implied by the market valuation of risk. This is a strong indication of the exposure of the GSEs to credit risk during the crisis, that translated to their substantial losses.

The results of this study can inform the theoretical literature that studies the market of credit risk in the U.S. While the GSEs provide a credit risk subsidy (Gete and Zecchetto 2018) the risk they are taking on is not reflected in the actual mortgage rates and guarantee fees. The results of this study construct a counterfactual scenario, in which the GSE guarantees would be removed. In such a scenario the mortgage rates would adjust based on the actual loan default probabilities. The time series of the market-implied mortgage rates can be used in the theoretical literature that develops models of credit risk, especially to study the period of the housing boom and bust cycle in the U.S. (see for example Garriga and Hedlund 2020).

This chapter can also inform the debate about housing finance reform, primarily in the U.S. The removal of GSEs would imply on average higher mortgage rates. The cost may fall on the borrowers or lenders or a combination of the two. An alternative solution would be an expanded market for CRT securities. With this market, institutional investors would take on the extra credit risk, that is not priced in the mortgage rates. In exchange for cashflows from mortgage pools, the investors would suffer losses during bad shocks to the mortgage market. The CRT investors, the majority of them being insurance and reinsurance companies and financial management companies, likely have the means to hedge potential losses in diversified portfolios. In the case of a financial crisis, similar to 2007-2009, institutional investors may lose up to 100% of their investment, and this would guard the taxpayers from taking on the weight of the losses.

Since the CRT market is still at an early age, it is important to study and understand how this market is likely to evolve. One critical question is whether investors are learning from the experience of previous shocks. While the hurricanes in this study were the first major shock for the newly formed CRT market, other catastrophic events followed, such as Hurricane Dorian in 2019 and wildfires in California that are becoming more devastating every year. It remains open for future research whether the market expectations of mortgage defaults are adjusting over time and becoming more accurate. Moreover, simulations of a variety of economic scenarios would contribute to a fuller understanding of the implications of removing the GSE guarantees.

3.9 Conclusiones

Este capítulo estudia cómo se comportaría el mercado hipotecario en un escenario sin las garantías GSE. Primero, muestro cómo el capital de los inversores institucionales en los mercados hipotecarios absorbería el riesgo crediticio a través de los CRT. Los CRT junior altamente expuestos al riesgo crediticio reaccionan de manera significativa ante la noticia de la llegada a tierra del huracán Harvey y del huracán Irma. Las recaladas generan expectativas de mayor probabilidad de incumplimiento y menores tasas de recuperación en caso de incumplimiento. Estas expectativas se demuestran en el mercado de CRT por un aumento repentino en los diferenciales de crédito. Los inversores exigen márgenes más altos para compensar el mayor riesgo.

Además, este capítulo estima las tasas hipotecarias implícitas del mercado y las comisiones de garantía en un mundo sin las garantías GSE durante el último cuarto de siglo. Durante este tiempo los mercados de la vivienda y las hipotecas experimentaron un ciclo de auge y caída. El modelo está calibrado por la reacción de los inversores de CRT a los huracanes. En el pico de los incumplimientos hipotecarios en 2007 las tarifas de garantía actuales fueron 2,25 puntos porcentuales más bajas que las implícitas en la valoración del riesgo de mercado. Este es un fuerte indicio de la exposición de las GSE al riesgo crediticio durante la crisis, que se tradujo en pérdidas sustanciales.

Los resultados de este estudio pueden proporcionar información a la literatura teórica que estudia el mercado de riesgo crediticio en Estados Unidos. Si bien las GSE brindan un subsidio al riesgo crediticio (Gete y Zecchetto 2018) el riesgo que están asumiendo no se refleja en las tasas hipotecarias y las tarifas de garantía. Los resultados de este estudio construyen un escenario contrafactual, en el que se eliminarían las garantías GSE. En tal escenario las tasas hipotecarias se ajustarían en función de las probabilidades reales de incumplimiento del préstamo. La serie

de tiempo de las tasas hipotecarias implícitas en el mercado se puede utilizar en la literatura teórica que desarrolla modelos de riesgo crediticio, especialmente para estudiar el período del ciclo de auge y caída de la vivienda en Estados Unidos. (ver por ejemplo Garriga y Hedlund 2020).

Este capítulo también puede proporcionar información al debate sobre la reforma del financiamiento de la vivienda, principalmente en Estados Unidos. La eliminación de las GSE implicaría, en promedio, tasas hipotecarias más altas. El coste puede recaer en los prestatarios o prestamistas o en una combinación de ambos. Una solución alternativa sería un mercado ampliado para valores CRT. Con este mercado los inversores institucionales asumirían el riesgo crediticio adicional, que no está incluido en las tasas hipotecarias. A cambio de los flujos de caja de las carteras hipotecarias los inversores sufrirían pérdidas durante las perturbaciones del mercado hipotecario. Los inversores de CRT, la mayoría de los cuales son compañías de seguros y reaseguros y compañías de gestión financiera, probablemente tengan los medios para cubrir pérdidas potenciales en carteras diversificadas. En el caso de una crisis financiera similar a la de 2007-2009 los inversores institucionales pueden perder hasta el 100% de su inversión, lo que evitaría que los contribuyentes asuman el peso de las pérdidas.

Dado que el mercado de CRT aún se encuentra en una edad temprana, es importante estudiar y comprender cómo es probable que evolucione este mercado. Una cuestión fundamental es si los inversores están aprendiendo de la experiencia de choques anteriores. Si bien los huracanes en este estudio fueron la primera gran conmoción para el mercado CRT recién formado, siguieron otros eventos catastróficos, como el huracán Dorian en 2019 y los incendios forestales en California, que se vuelven más devastadores cada año. Queda abierto para futuras investigaciones si las expectativas del mercado sobre incumplimientos hipotecarios se están ajustando con el tiempo y son cada vez más precisas. Además, las simulaciones de una variedad de escenarios económicos contribuirían a una comprensión más completa de las implicaciones de eliminar las garantías GSE.

Figures

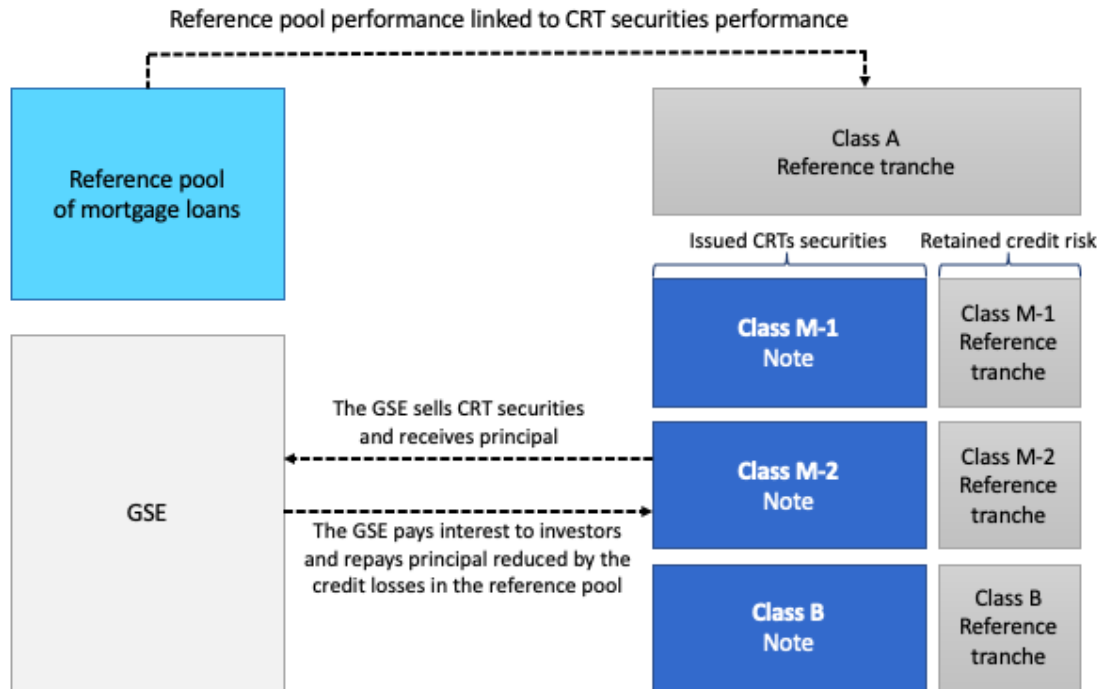


Figure 3.1. Structure of sample Credit Risk Transfer transaction. The figure shows a sample CRT transaction linked to a reference pool of loans. Credit losses on the reference pool reduce the obligation of the GSE to pay interest and repay principal on the CRT securities. This sample transaction contains, from the most subordinate to the most senior, a subordinate tranche (Class B), two mezzanine tranches (Class M-1 and M-2) and a senior tranche (Class A). The credit losses are allocated to tranches starting with the most subordinate tranche, while repayments are allocated starting from the most senior tranche. A vertical slice of each of the tranches is retained by the GSE, while the remaining credit risk is sold to investors. The most senior tranche (Class A) is fully retained by the GSE.

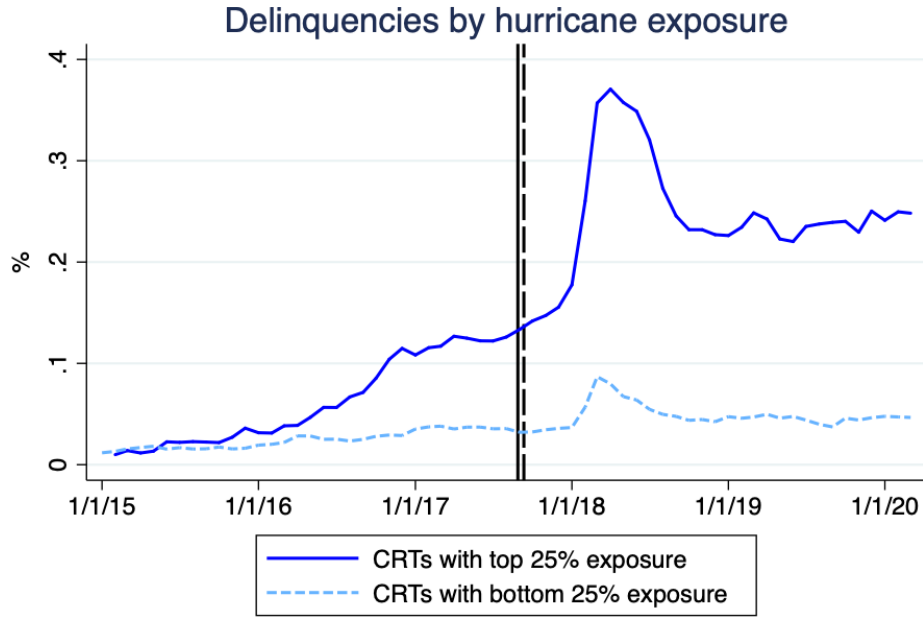


Figure 3.2. Mortgage delinquencies in the CRT pools by geographical exposure to hurricanes. The figure plots the average share of unpaid principal balance from mortgages delinquent for more than 120 days, for CRT mortgage pools from Freddie Mac that had the highest and lowest geographical exposures to the hurricane-hit areas. The exposed areas consist of 108 counties listed by the Federal Emergency Management Agency (“FEMA”) as a major disaster area as a result of Hurricane Harvey or Hurricane Irma as of October 23, 2017. The solid vertical line indicates August 28, 2017, the trading day after Hurricane Harvey’s landfall in Texas, and the dashed vertical line September 11, 2017, the trading day after Hurricane Irma’s first landfall in Florida.

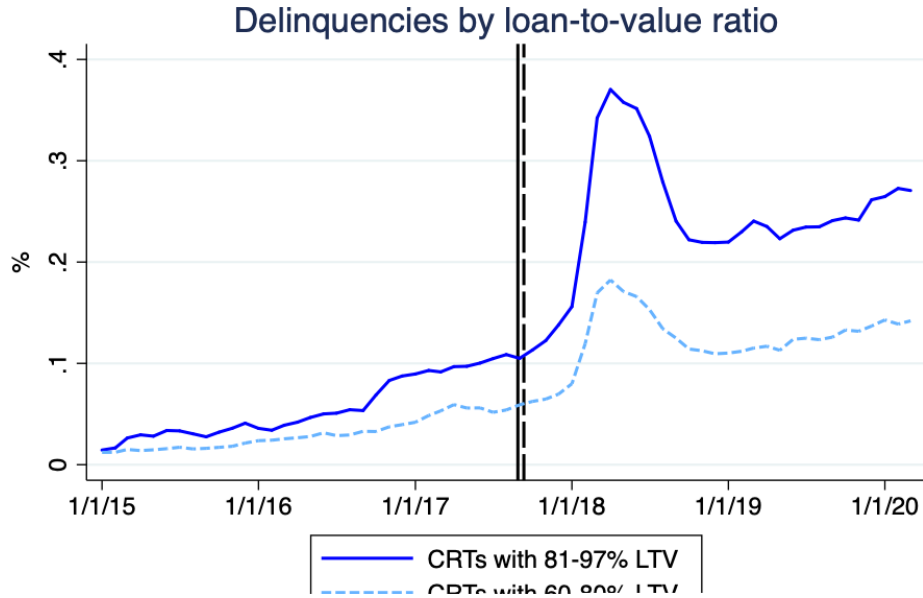


Figure 3.3. Mortgage delinquencies in the CRT pools by loan-to-value ratios. The figure plots the average share of unpaid principal balance from mortgages delinquent for more than 120 days, for CRT mortgage pools from Freddie Mac with high and low loan-to-value ratios. The solid vertical line indicates August 28, 2017, the trading day after Hurricane Harvey’s landfall in Texas, and the dashed vertical line September 11, 2017, the trading day after Hurricane Irma’s first landfall in Florida.