

University of Montreal

**How Do Disruptions in the Mortgage Market  
Affect Consumption? Empirical Evidence from the  
U.S.**

By

**Alex TIEUMENA NDOGMO**

Department of Economics  
Faculty of Arts and Sciences

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Université de Montréal

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**Alex TIEUMENA NDOGMO**

Département de Sciences Économiques  
Faculté des Arts et des Sciences

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## **Abstract**

This paper documents a strong empirical relationship between the supply of mortgage loans and consumption in the U.S. during the 2008 financial crisis. The estimates indicate that a negative shock to the supply of mortgage is associated with a decline in the consumption expenses. We present a stylized model of household credit and consumption, and analyse implications of an adverse shock to the mortgage supply. The model predicts that households react to an adverse mortgage shock by cutting consumption expenditures, especially if they are at their borrowing constraints. Empirically, following a one standard deviation decrease in mortgage issuance, we found that the consumption growth was affected in 2009 and 2010 with a decrease of 0.051 and 0.036 percentage point respectively. Mortgage refinance shock accounts for approximately 50% of the decline of in consumption growth. Lower-income households are more vulnerable and react more strongly to adverse shocks than higher-income households.

Keywords: Mortgage, Financial Shock, Heterogeneity, Consumption

## Résumé

Cet article documente une forte relation empirique entre l'offre de crédits hypothécaires et la consommation aux États-Unis au cours de la crise financière de 2008. Les estimations indiquent qu'un choc négatif à l'offre d'hypothèque est associé à une baisse des dépenses de consommation. Nous présentons un modèle stylisé de crédit et de la consommation des ménages, et analysons les implications d'un choc négatif sur l'offre de crédit hypothécaire. Le modèle prédit que les ménages réagissent à un choc négatif d'offre hypothécaire en réduisant leurs dépenses de consommation, surtout s'ils sont confrontés à des contraintes d'emprunt. Empiriquement, suite à une baisse de 1% de l'offre hypothécaire, nous avons constaté que la croissance de la consommation avait été affectée en 2009 et 2010 avec une diminution de 0.051 et de 0.036 point respectivement. Un choc sur le refinancement hypothécaire représente environ 50% de la baisse de la croissance de la consommation. Les ménages à faible revenu sont plus vulnérables et réagissent plus fortement aux chocs défavorables que les ménages à revenu plus élevé.

Mots clés: Prêts Hypothécaires, Shocks Financiers, Hétérogénéité, Consommation

# 1 Introduction

The recent crisis has plunged the world economy into a deep recession over the past few years and has had severe consequences on both real and financial economy. Many explanations were given for the causes of that deep recession; some authors pointed out the fall in aggregate demand (Mian and Sufi, 2014), others pointed the uncertainty (Baker, Bloom and Davis, 2016, Bloom et al., 2012), and others structural factors. As the consequences, many sectors were severely harmed and had a long and very slow recovery. Employment fell by over 7% in US, the public finance experienced a crunch, firms balance sheets were on deficit<sup>1</sup>. Among the factors that explain the current economic downturn, while reasonable hypotheses have been put forward, an empirically relevant approach must quantitatively explain four facts that collectively define the recession: the sharp rise in household defaults, the fall in house prices, the drop in consumption (durables), and the rise in unemployment.

Over the past few years, especially at the offset of the great recession, the topic of household finance has brought the attention of many researchers (Baker Scott R, 2013, Mian, Rao and Sufi, 2010, 2013). These authors find that the crisis had several effects on the households finance, regarding their limited access to credit, their leverage, their balance sheet and finally their consumption. In fact, Mian and Sufi (2010) argue that the components of GDP that initially declined in 2007 and early 2008 were fixed residential investment and durable consumption.

As rich as these studies can be, there is still a remaining question: how much the decline in non-housing consumption can be attributed to or explained by the tightening in the supply of credit to households? What is the geographical distribution of the shocks to the supply of credit? Is there any heterogeneous effect across households? This paper tries to give an empirical explanation to these questions.

The topic in itself raises a lot of interest considering the following facts: *(i)* the US economy is mostly a consumption-based economy, that is, when the consumption suffers from any friction, there will be a direct impact on the entire economy and could easily lead to a recession; *(ii)* for the last 2 decades, the market of credit has been expanding and showed to researchers a lot of interest, especially at the onset of the 2008 crisis. So it's important to evaluate what the effects could be in all the sectors of the economy, especially the non-housing consumption, which accounts for a large part in the aggregate

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1. John Mondragon (2014), Chodrow, Reich (2014)

demand.

The goal of the present paper is to assess to which extend disruptions in the credit market affect households' non-housing consumption. More specifically, the paper tries to: (i) provide estimates of the supply shocks to household credit, using the methodology used by Greenstone and Mas (2012), followed by Amiti and Weinstein (2013) and Niepmann, Schmidt Eisenlohr (2013); (ii) estimate the elasticity of consumption<sup>2</sup> with respect to declines in household credits caused by credit supply shocks. We give the average effect across counties; (iii) take into account the heterogeneity among households in different counties, by providing evidence of interesting heterogeneous effects on the rich versus poor counties. We also check if, for a given size of the shock, the magnitude of the effect differ for counties with different characteristics; (iv) finally analyse these effects in a simple theoretical frame. For that, we propose a simple model inspired by DeFusco and Paciorek (2016) and John Mondragon (2014) that use two types of borrowers (constrained and non constrained) with their preferences that face optimization problems.

As documented in the literature, there are two main ways a credit shock can affect financial stability through the consumption. The relationship between household debt and future growth and financial stability depends on several factors and can be negative or positive. On one hand, the permanent income theory argues that household debt has beneficial effects on the macroeconomy and on financial stability. Households that anticipate an increase in future income will increase their debt to smooth their consumption or make large investments in nonfinancial assets or education<sup>3</sup>. The relationship may be positive if agents behave in a rational, forward looking manner and contract debt solely with an eye on future income growth and returns to capital in the absence of financial frictions and binding borrowing constraints. On the other hand, newer theories and empirical evidence show that the relationship between household debt and macro-financial stability can also be negative. More recent consumption and debt theories relax some of the assumptions of the permanent income model and consider the consequences of borrowing constraints, negative externalities, and behavioral biases<sup>4</sup>.

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2. Due to the availability of the data, we will only focus on the non-housing consumption.

3. In this context, demographics and the distribution of income and debt matter. Younger households that anticipate future income growth would borrow more against their future income (Blundell, Browning, and Meghir 1994). Rajan (2010) and Kumhof, Rancière, and Winant (2015) have argued that increased income and wealth inequality led to the rapid growth of household debt in the United States and eventually to the financial crisis in 2008. Coibion and others (2017) find that, over the period 2001 – 2012, income inequality may have indirectly operated as a screening device for banks, given that they lend less to low income households in high inequality regions in the United States.

4. Market incompleteness may also play a role in households' borrowing and saving decisions

The empirical results show that there is a positive relationship between the mortgage shock and the change in consumption. Counties that experience the biggest negative shock in the issuance of the mortgage had faced the largest decline in consumption. There is an heterogeneity regarding the income groups. When the counties are clustered into 3 groups according to their income, we found that the "poor" counties tended to be more vulnerable and faced biggest decline in the consumption than the "rich" ones.

The rest of the paper is organized as follow: section 2 presents the literature review and shed light ont the recent works that had been in relation to the present work; section 3 presents the model and the economic setting; section 4 describes data and compute some summary statistics; section 5 elaborates the empirical analysis, from how the mortgage shock is computed to the different econometric results; finally, section 6 concludes.

## 2 Literature Review

The paper relates to a number of strands of literature in both macroeconomics and finance and can be classified in three main groups.

The first part summarises the recent works on the credit supply shocks. It is a topic that is still very growing and raises much attention these past years. These are related to the credit shocks and its effect on the economic activity. Most of the studies are focusing on credit to firms and businesses, but only a few on housing credit. These include John Modragon (2014), Jagdish Tripathy (2016), Greenstone and Mas (2012), Chodorow-Reich (2014) and DiMaggio and Kermani (2014), Amiti and Weinstein (2013).

John Modragon (2014) studied the relation between the contraction in the supply of credit to households and the decline in the employment during the Great Recession. He instrumented credit supply shock with county's exposure to the collapse of a large previously healthy lender (Wachovia Bank). He found an elasticity of employment with respect to household credit of 0.3, caused by decline in housing and non-housing consumption. He estimated a size of the shock using non parametrical identification of the lender-specific shocks to household and found a global contribution to the decline of employment of 3.6% between 2007 and 2010.

Instead of using the county exposure to a specific lender, Jagdish Tripathy (2016) exploited variations across Mexican municipalities to look at the effect of household credit shock on sectoral composition. He identified a negative shock to the credit supply resulting from exogenous macro-prudential regulations in early 2012 in Spain. He showed that municipalities with a greater

exposure to the shock experienced a higher drop in investments in the non-tradable sector (1.6-3.5), whereas investments in the tradable sector remained unaffected.

Working on loans to businesses, Greenstone and Mas (2012) estimates the effect of the reduction in the credit supply that followed the 2008 financial crisis on the real economy, especially on employment. Exploiting substantial heterogeneity in the extent to which different national bank cut their small business lending during the financial crisis, and isolating the portion of these cuts attributed to supply factors, they predicted the change in county level small business lending over 2007-2009 period using interactions of banks' pre-crisis county market shares and their national change in lending. Amiti and Weinstein (2013) used the same methodology to discuss the effect of supply-side financial on firms' investment in Japan from 1990 to 2010.

To address the same question, Chodorow-Reich (2014) instead used the dispersion in lender health following the Lehman crisis as a source of exogenous variation in the availability of credit to borrowers. Firms that have pre-crisis relationships with less healthy lenders had a 55% lower likelihood of obtaining a loan following the Lehman bankruptcy, paid a higher rate if they did borrow, and reduced employment by more, compared to pre-crisis clients of healthier lenders.

DiMaggio and Kermani (2014) studies the impact of credit expansion on the house prices and real economic activity. The methodology is quite different from other in the sense that they exploit heterogeneity in the market share of national banks across counties and in state anti-predatory laws to instrument for an outward shift in the supply of credit. The particularity of the instrument is that it allows to investigate, controlling for regional differences, how lending to riskier borrowers affects several sectors of the economy. The results show that the increase of the lending led to increase of house prices and expansion of employment in the non-tradable sector. But these effects were followed by a decline in loan origination, house prices and employment of similar magnitude in the subsequent years.

All these papers have in common the estimation of the credit supply shocks using different approaches. But the outcome is mainly investments and employment and the question of consumption response to those shocks is not addressed. To contribute to this growing literature, we look at the effect on the consumption, which is also an important part of the aggregate demand and thus the economic activity.

Furthermore, our paper uses mortgage data. So, it also relates to the literature concerning the mortgage credits and its implication on the economic activity. The more close to our study are Mian and Sufi (2009, 2010), Favara, Imbs (2010), Justiniano, Primiceri and Tambalotti (2014).

Mian and Sufi (2009) attempt to separate the effect of an expansion in the supply of credit from potentially confounding effects of contemporaneous changes in the demand for mortgages. They argue that the expansion in the supply of mortgage credit led to a rapid increase in house prices from 2001 to 2005 and subsequent defaults from 2005 to 2007. Their approach is designed to isolate the causal effect of the supply expansion of mortgage credit growth, house price growth, and subsequent defaults. On the other hand, Favara, Imbs (2010) identifies exogenous shifts in the supply of credit with regulatory changes to bank branching across US states, traces their effects on the size and standards of mortgage loans and evaluates their impact on house prices. They found a significant effect on the house prices and used US branching deregulations between 1994 and 2005 as instruments for credit<sup>5</sup>. Justiniano, Primiceri and Tambalotti (2014) show that the credit supply in the mortgage market driven by looser lending constraints was the main cause of the housing boom that preceded the Great Recession.

The different studies mentioned above somehow lack a theoretical model to explain the channel through which the effect of a mortgage shock on the economic activity is driven. We try to complete that with a theoretical model that explains clearly how can a reduction of the mortgage issuance affect non housing consumption.

Finally, because our study concerns the consumption as the main interest outcome, it's related also to Mian and Sufi (2010), Mian, Rao and Sufi (2013) and Baker Scott R (2013).

Mian and Sufi (2010) focused on cross-sectional variation of economic variables across US counties in the severity of the recession to assess the household leverage as a powerful predictor of the 2007-2009 recession. More specifically, they found that counties in the US that experienced a large increase in household leverage from 2002 to 2006 showed a sharp relative decline in durable consumption starting in the third quarter of 2006. Similarly, counties with the highest reliance on credit card borrowing reduced durable consumption by significantly more following the financial crisis of the fall of 2008. Household leverage growth and dependence on credit card borrowing explain a large fraction of the overall consumer default, house price, unemployment, residential investment, and durable consumption patterns during the recession.

Mian Rao and Sufi (2013) provide detailed empirical evidence on the distribution of wealth shocks across the US population at the onset of the Great Recession and on the consumption. They used the cross-sectional variation in consumption and net housing wealth decline at the county level and found several results: (i) the elasticity of consumption with respect to housing net

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5. They argued that the deregulation affected the supply of mortgage loans, and via its effects on credit, the price of housing.

worth varies from 0.6 to 0.8, *(ii)* households with larger decline in housing net wealth experience a stronger reduction in credit limit and greater difficulty in refinancing their mortgage into lower interest rates, *(iii)* The Marginal Propensity to Consume (MPC) falls between 5 and 7 cents for every dollar fall in housing net wealth and is disproportionately borne by households that have an equity claim on the housing market.

Baker Scott R (2013) exploits a detailed new dataset with comprehensive financial information on households to investigate the interaction between household balance sheets, income, and consumption during the Great Recession. The strategy is to match households with their employers and use shocks to these employers to derive persistent and unanticipated changes in household income. He found that highly indebted households are more sensitive to these income fluctuations and that a one standard deviation increase in debt-to-asset ratios increases the elasticity of consumption by approximately 25%.

For this part, the authors did not really assess the impact of a credit supply shocks to consumption. Instead, they found a relation between household wealth shock - notably their leverage and income - and consumption. Andreas Lehnert (2004): Housing, consumption and credit constraints. The author finds a relationship between house prices and consumption. Particularly, he tests whether the consumption impact of price shocks is greater among credit constrained households than among other households. He identifies credit constrained households by age.

To complete these studies, we include an important heterogeneity source, which is the income. We provide empirical results and show that there is a heterogeneity on the effect of mortgage shock on the consumption based on the income of households; using a simple classification, "poor" households are more affected than "rich" ones.

### 3 The model

In this section we develop a very simple model of heterogeneous households that borrow from financial intermediaries (lenders). In case of a change in the supply of mortgage, we look at the effects on the non-durable consumption.

The model is a combined modification of John Mondragon (2014), Justiniano, Primiceri and Tambalotti (2015) and DeFusco and Paciorek (2016) The goal of this model is twofold: **(i)** First, we aim to develop a theoretical mechanism through which a supply shock in mortgage could affect non-durable consumption through the interest rate channel; **(ii)** Secondly, we aim

to construct the credit supply shock so that we can match the methodology of Greenstone and Mas that is used in our paper.

### 3.1 Economic setting

We consider a two-period model where there is a representative consumer (household). The household holds physical capital (which is to be his home once he buys it) that is financed with the mortgage. There is no uncertainty.

Since we want to derive an effect of the mortgage change in the non-durable consumption, we will shut down the hypothesis of homeowner/renter and consider that the household has housing consumption ( $h$ ) in the first period at an exogenous per-unit price of  $p$  that can be depreciated in the second period at rate  $\delta$ . The household has the choice to finance his housing consumption with a mortgage,  $m$ , or not. In the case he chooses to finance his housing consumption, the mortgage must not exceed the value of their house<sup>6</sup>. In the second period, the house faces some depreciation, the mortgage is paid off, and the household consume all of their remaining wealth. The borrower solves the following problem:

$$\begin{aligned} \max_{\{c_1, c_2, I \in [0,1], m, h\}} \quad & V_I(C) = u(c_1, h) + \beta u(c_2, h) \\ \text{s.t.:} \quad & \begin{cases} c_1 + p \cdot h \cdot I = y_1 + m \cdot I \\ c_2 + (1+r)m \cdot I = (1-\delta) \cdot p \cdot h \cdot I + y_2 \\ 0 \leq m \leq \theta \cdot p \cdot h \end{cases} \end{aligned}$$

Where  $c_1$  and  $c_2$  denote the consumption of the non-durable goods at the first and second period respectively,  $u$  is the utility function derived from that consumption and from the housing consumption,  $\beta \in (0,1)$  is the discount factor,  $I$  is an indicator variable that express the choice to take the mortgage or not<sup>7</sup>,  $h$  is the housing consumption valued at price  $p$ ,  $m$  is the mortgage loan and  $\delta$  is the depreciation factor of the house.  $\theta$  represent the maximum allowed Loan-to-value ratio. It is the maximum fraction of the value of the house the borrower can get. In the literature, it's referred as the leverage.

### 3.2 Implications of the model on the consumption growth

The problem of the household can be rewritten as:

$$\max_{m, h} \{V_I(C) = u(y_1 + m \cdot I - p \cdot h \cdot I, h) + \beta u((1-\delta) \cdot p \cdot h \cdot I \cdot y_2 - (1+r)m \cdot I, h)\}$$

6. The lender use that constraint to make sure that somehow, the household is able to repay the mortgage he took

7. Depending on the utility function,  $I$  may never be 0. This would be the case if the marginal utility is decreasing, that is, the household would always want to take a mortgage

$$\text{s.t.}: 0 \leq m \leq \theta.p.h$$

✓ **I = 0: The consumer doesn't take the mortgage**

In this case, the constraints of the model give us:

$$\begin{cases} c_1 = y_1 \\ c_2 = y_2 \end{cases}$$

which entails

$$g_c = \frac{c_2}{c_1} = \frac{y_2}{y_1}$$

Then the consumption growth rate is simply the income of the second period relative to the first period. Therefore it's not affected by a shock in the mortgage.

The Value function is:

$$\begin{aligned} V_{I=0} &= u(c_1) + \beta u(c_2) \\ &= u(y_1) + \beta u(y_2) \end{aligned}$$

✓ **I = 1: The consumer takes the mortgage** The Lagrangian gives:

$$\mathcal{L} = u(y_1 + m.I - p.h.I, h) + \beta u((1 - \delta).p.h.I.y_2 - (1 + r)m.I, h) - \lambda(m - \theta.p.h)$$

The F.O.C (First Order Condition) gives:

$$\begin{cases} m: & u_1(c_1, h) - \lambda = \beta(1 + r)u_1(c_2, h) & (1) \\ h: & -pu_1(c_1, h) + u_2(c_1, h) + \beta p(1 - \delta)u_1(c_2, h) + \beta u_2(c_2, h) + \lambda.\theta.p = 0 & (2) \\ & \lambda \geq 0 \quad \text{and} \quad (\lambda = 0 \quad \text{if} \quad m < \theta.p.h) & (3) \end{cases}$$

- Equation (1) is the classic Euler Equation (EE): It equates the marginal benefit of higher consumption today against the marginal cost of lower consumption tomorrow.
- Equation (2) characterizes the *housing consumption demand* by the borrower: It equates the net cost of forgone consumption today to purchase an additional unit of housing today, with the benefit of enjoying this house tomorrow, and then selling it (after depreciation) in exchange for goods. Basically it shows the inter temporal condition between the decision of consume and the decision to invest in housing consumption.
- Equation (3) defines two cases; the first where the borrower is not constrained ( $m = \theta.p.h$ ) and the second where he is constrained ( $m < \theta.p.h$ )

We consider a particular form of the utility function so we can derive the different demand functions of the household. For simplicity, we consider the

logarithm utility function:

$$u(c, h) = \ln(C) + \alpha \ln(h)$$

The parameters  $\beta, \delta$  are assumed to be constant.  $\alpha$  is the portion (or the share) of the total consumption that is allowed to the housing consumption.

Given this utility function, the marginal utility is decreasing, that will lead the consumer to always want to consume. Therefore, he will always be willing to take a mortgage ( $I = 1$ ).

We solve the problem and derive the different demand functions: Consumption, Mortgage and Housing.

### 3.2.1 Non constrained borrower

The non constrained borrower is the one that doesn't hit his constraint; that is, he is characterized by:

$$m < \theta.p.h$$

Therefore, his lagrange multiplier is null.

**Proposition 3.1.** *Then consumption growth for an unconstrained agent is given by:*

$$g_c = \frac{c_2}{c_1} = \beta(1 + r)$$

The housing demand is a decreasing function of the price of the house and the interest rate, but is an increasing function of the incomes in each period. The consumption in the first period is decreasing in the interest rate while in the second period it's an increasing function of  $r$ . This highlights the substitution effect in the model. In the case there is an increase on the mortgage rate, the consumer finds it difficult to consume today ( $c_1$  drops), especially when he took a mortgage; therefore he has to reduce the actual consumption to repay<sup>8</sup> his mortgage and increases his tomorrow consumption ( $c_2$  jumps up).

To look at the effect on the consumption, we are going to take the derivative of the consumption growth with respect to the mortgage and look at its sign.

The borrower takes the interest rate  $r$  as given, but the latter is a function of the mortgage supply<sup>9</sup>. So, the inverse supply function of the mortgage

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8. Unfortunately, the repayment are not taken into account in this model

9. We focus non the supply side because we want to see the effect of the supply shock of mortgage on the non housing consumption.

would be

$$r \equiv r^s(m)$$

Therefore, the consumption growth would be

$$g_c = \frac{c_2}{c_1} = \beta(1 + r^s(m))$$

Considering a specific supply function of mortgage, the law of supply can be applied, and it states that the interest rate is an increasing function of the amount of mortgage offered by lenders. So,  $r^s(m)$  is an increasing function of  $m$ . Then, an increase in  $m$  will increase the supply rate  $r^s$ , and hence increase the consumption rate. That is, the borrower reduces his current to increase future consumption.

### 3.2.2 Constrained borrower

The constrained borrower hits his constraint and because he want more mortgage to purchase his house, he will reach the upper limit of the amount allowable for him:

$$m = \theta.p.h$$

**Proposition 3.2.** *The consumption growth for a constrained agent as a function of the mortgage  $m$  is:*

$$g_c = \frac{c_2}{c_1} = \frac{y_2 + (\frac{1-\delta}{\theta} - (1+r))m}{y_1 + (\frac{\theta-1}{\theta})m}$$

In this case, we have:

- $\frac{\partial c_1}{\partial m} = \frac{\theta-1}{\theta} < 0$ , because  $\theta < 1$ . That is, an increase in  $m$  leads to a decrease of the current consumption.
- $\frac{\partial c_2}{\partial m} = \frac{1-\delta}{\theta} - (1+r)$ . The sign of this expression depends on the value of  $\theta$ ,  $\delta$  and  $r$ . Let's recall that  $\theta$  represents the maximum borrowing capacity (leverage). It also gives an indication of the level of debt of a borrower. For a borrower that is not constrained, his leverage  $\theta$  is low; that is, he is more trustworthy as his capacity to repay the debt. We have:

$$\begin{aligned} \frac{\partial c_2}{\partial m} > 0 &\Rightarrow \frac{1-\delta}{\theta} > 1+r \\ &\Rightarrow \theta < \frac{1-\delta}{1+r} \end{aligned}$$

If  $\theta$  is small enough, then in order to find the substitution effect in consumption, we'll find that a positive mortgage shock will increase tomorrow consumption, and hence the consumption growth.

With this result, we see that whether the borrower is constrained or not, a negative shock of the mortgage supply will have a negative effect on the non housing consumption. One concern may be the magnitude of the effect. We believe that comparing two borrowers with one constrained and the other not, the negative effect will not be the same on both. The constrained one will have the worse effect, although the non constrained one will have a lighter negative effect.

Another limit of this model is, it only shows the effect of a reduction of the mortgage issuance on the consumption but not the actual supply side of the reduction. Since the focus of this paper is to look at the supply shock, we aim to present a framework where we disentangle the supply and the demand side of the mortgage shock, which will be implemented in the identification strategy.<sup>10</sup>

## 4 Data Description

### 4.1 Data Source

According to the different variables that we use in our study, we have 4 principle data sources: Home Mortgage Disclosure Act (HMDA), AC Nielsen consumer panel, New York Federal Reserve Equifax/Consumer Credit Panel dataset and IRS Statistics of Income.

The data I use to measure the household credits are from the Home Mortgage Disclosure Act (HMDA). It's an application-level database constructed by the Federal Financial Institution Examination Council (FFIEC) from disclosure reports submitted by mortgage lenders, by counties and by Metropolitan Statistical Area (MSA). I specifically rely on the flow of "Home purchase", the "Home Improvement" and the "Home refinance" to measure the household credit<sup>11</sup>. The data give various characteristics of the loan and applicant by county, including: the loan amount, the population, the loan purpose (home purchase, home refinance or home improvement), the property type, the median income, the identifier of the lender, the census tract of the property for which the loan is used. The sample period goes from 2007 to 2011.

Among many types of mortgage loans, the HMDA provides mainly the "conventional loans". Basically, the conventional mortgage is a type of home buyer's loan that is not offered or secured by a government entity, like the Federal Housing Administration (FHA), the U.S Department of Veteran Af-

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10. This is well documented in the Appendix.

11. Ideally, to measure the impact of the credit shocks to households, we would use the consumption credit, not the mortgage credit. But the absence of data on consumption credit forced us to use the mortgage data. See John Mondragon (2014) for more details.

fairs (VA), but rather available through or guaranteed by private lender, or the two government sponsored enterprises, the Federal Mortgage Association (Fannie Mae), and the Feral Home Loan Mortgage Corporation (Freddie Mac)<sup>12</sup>. This is the type of mortgage that will be used in our study.

For non-housing consumption, I rely on the AC Nielsen consumer panel. This consumer panel data represents a longitudinal set of approximately 60,000 U.S. households - from 2007 onwards - who continually provide information to Nielsen about their households, what products they buy, the prices, as well as when and where they make purchases. Products include all Nielsen-tracked categories of food and non-food items, across all retail outlets in all U.S. markets. Nielsen samples all states and major markets. The panelists are geographically dispersed and demographically balanced. The data contain information on households at the barcode level and at a quarterly frequency.

Data on consumer debts (auto and credit card debts) are taken from the New York Federal Reserve Equifax/Consumer Credit Panel dataset.

Although there are approximately three thousand counties in the U.S., all of them will not be used in our study. In fact, the choice of the counties for our study depends first on the availability of the data in those counties, and most importantly they size. The activities in the counties are very heterogeneous due to their sizes, which is defined here by their populations. Data on the populations come from the Current Population Survey (CPS) available at the Census Bureau. Using that variable, we chose counties that have an estimated population of at least 10 thousands with credit reported in 2010.

The income data are taken from the IRS Statistics of Income (SOI). The SOI data reports the total amount of income received by households at the ZIP code level. The total income includes Wages and salaries, interest payment, dividend, and some alimonies. All those elements form the Adjusted Gross Income (AGI) and represents the taxable income for each household. Using the population criteria, we merged the different datasets that we have (NyFed, Nielsen and HMDA) and brought down to 2150 counties in our study.

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12. Fannie Mae (officially the Federal National Mortgage Association, or FNMA) is a government-sponsored enterprise (GSE) - that is, a publicly traded company which operates under Congressional charter - to stimulate homeownership and expand the liquidity of mortgage money by creating a secondary market. Freddie Mac (FHLMC) is a stockholder - owned, government - sponsored enterprise (GSE) chartered by Congress in 1970 to keep money flowing to mortgage lenders in support of homeownership and rental housing for middle income Americans. The FHLMC purchases, guarantees and securitizes mortgages to form mortgage - backed securities.

## 4.2 Summary Statistics

Before we get into the estimations, it's important that we take a look at some descriptive analysis to see how the different variables interact and what effect could we expect in the econometric estimations.

During the whole period, the overall loan origination were decreasing, but there was a pick in 2009. Also, the biggest component on the total origination in the mortgage is the refinance. So, the whole evolution in the mortgage is mainly attributed to the home refinancing.

Figure 1 shows the evolution of the mortgage issuance and its different purposes from 2007 to 2011. The pick in 2009 can be explained with the movement of the interest rate. In fact, as explained in the literature, the decline of the interest rate (as shown in the Figure 2) is an opportunity for borrowers to renegotiate or to take a second mortgage (for those who already got one), to refinance the first one at lower prices. This is to get low repayment stream for their loans over time. But as time goes, the trend is declining. As documented in the literature, the interest rate is a negative function of the mortgage debt. Therefore, as the mortgage issuance decreases over time, we normally expect the interest rate to go up. But this relationship is not what is shown on the figures. One thing that could explain this is the extensive margin, that is, even when the loan origination were cut globally, they were more cut to the poorest (Subprime) and offered to the richest (Prime).

As shown in Figure 3, there is a negative relationship between the consumption and the mortgage issuance. But this figures hides a lot of heterogeneity, because according to some factors (the average income for example) the relation may not be the same. We can descriptively look more in details the interactions of the consumption and the mortgage issuance throughout the years. For that, we split the data into 3 income groups (top quartile (25%), bottom quartile (25%) and middle 50%) regarding their 2008 – 2011 income. For each group, we look at the number of loans issued, the amount of the loan issued and the total consumption expenditures. On one hand, Figure 4 confirms that the loans were cut off from the "poorest" counties and were more offered to the "richest", because of their solvability and their ability to repay and sustain a debt. Looking at the curves, we can predict a positive relation between the mortgage supply shock and the consumption for the 3 groups for at least the first 3 years (2008 – 2010). In 2011, there is a sort of negative relation between both. On the other hand, in Figure 5, the number of loans in each income group is highly correlated with the amount of loan issued in these groups. This could give a descriptive explanation as to why the mortgage were still decreasing even though the interest rate were still decreasing. This result shows us that the supply of loans is based both on the *intensive* and the *extensive margin*: The intensive margin for the amount of loans given to different income groups, and the extensive margin for the

number of the loans that were offered to different income groups. In the econometric specification, we will go into more details to explain the contribution of some factors on the issuance of the mortgage.

Table 1 presents the statistics of the consumption from 2008 to 2011. we see a decline in the consumption growth in 2008 and 2009 of 0.14% and 0.28% respectively, which are the years were the crisis were more severe and thus there were decline in the aggregate demand, especially in consumption. For those same years, the median value is negative, meaning that the consumption of 50% of the population fell under 0.13% and 0.34% respectively. But right back in the 2010 and 2011, there were a substantial growth in the consumption of 0.21% and 0.47%.

Comparing the consumption habit between the income groups (that we created above), Table 2 provides us the growth in each income groups. We can see that throughout the years, the bottom quartile was the most affected by the crisis<sup>13</sup>. Again, 2009 was the toughest year for all of them and the post crisis (2011) was economically positive with all positive growths.

The motivation of choosing only 3 lenders (JP Morgan Chase, Bank of America, Wells fargo) among many others are due to their intensity in the activity of lending to the households. More specifically, among around 8000 lenders each year, those 3 lenders account for 20 to 27% of the share of all the lending in the country, just like shown in figure 6. Figure 7 shows the co-movement between their lending and the total lending in the country; the curves show that the chosen lenders are very representative of the total lending in the country. .

## 5 Empirical Analysis

Our main goal is to elaborate an empirical methodology to look at the effect of the mortgage shock on the non housing consumption. First, we compute the mortgage shock following the theoretical model described in the appendix. Then, we validate the instrument (relevance of the instrument and omitted variables). Later on, we provide the main results.

The average effect of the credit supply shock to households on consumption can then be estimated sing the following regression:

$$\Delta \text{Log}(C_{it}) = \alpha_i + \beta_t + \delta \times \text{Shock}_{it} + X_{it} + \epsilon_{it} \quad (1)$$

Where:  $C_{it}$  is the consumption spending at time  $t$  in the county  $i$ ;  $\alpha_i$  and  $\beta_t$  are county and time fixed effect respectively;  $X_{it}$  is the set of control vari-

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13. If we consider that the only factor that affected their consumption habit is the crisis.

ables<sup>14</sup>; and  $\epsilon_{it}$  is the error term. Under the assumption that the computed supply shock are not systematically correlated with unobserved characteristics that vary at the time - county level and are correlated with consumption,  $\delta$  corresponds to the causal effect of mortgage supply shocks on consumption growth. Expressed in formulas, the identification assumption is:  $E(\text{Shock}_{it} \times \epsilon_{it}) = 0$ . In other words, a lender's change in lending does not covary with factors that determine the county - level outcomes.

The identification approach exploits within-state across-county heterogeneity and their exposure to the three biggest mortgage lenders from 2007 to 2011. The main challenge of the identification strategy is to provide good estimates of the credit shocks that specifically isolate the supply side and the global effect on consumption with regards to that heterogeneity. The heterogeneity across counties will help me to separate the credit supply shock from other possible confounding mechanisms (especially demand shock).

## 5.1 Estimating the credit supply shocks

To estimate the credit supply shock, we use the methodology of Greenstone and Mas (2012), followed by Amiti and Weinstein (2013) and Niepmann, Schmidt and Eisenlhor (2013). This has the advantage that it helps us to disentangle both the supply and demand variations of the loan origination.

This empirical estimation finds its theoretical background in John Mondragon (2014)<sup>15</sup>

An originated loan can be seen as a result from the confrontation between the borrower and the lender, and is susceptible to confounding demand and supply shocks. Therefore, a change in the origination of loan to household contains demand effects and supply effects, which we need to separate. To address that, we construct an instrument for bank lending in county  $i$  in year  $t$  as the sum across all banks that operate in  $i$  of the interaction between bank market shares in  $t - 1$  and changes in those banks' national lending between  $t - 1$  and  $t$ .

Specifically, for each year  $t$ , we run the following regression:

$$\Delta \ln(L_{ijt}) = d_{it} + s_{jt} + e_{ijt} \quad (2)$$

Where:  $L_{ijt}$  is the amount of loan originated from the lender  $j$  to the county  $i$  at time  $t$ ;  $d_{it}$  is the borrower fixed effect, which can be interpreted

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14. The set of control variables are well documented in the econometric section. It includes Income, mortgage delinquencies, credit card delinquencies, refinance,

15. The model is developed in Appendix A. For further reading, the reader can directly refer to the paper of the author.

as the variation in banks' changing that is due to the conditions of the local economy<sup>16</sup>. We interpret it also as demand effect.  $s_{jt}$  is the lender fixed effect, which we interpret as the supply effect.

Here we are interested in the vector  $s_{jt}$  that is computed for every pair of consecutive years from 2007<sup>17</sup>. We finally use the lender's specific supply shock ( $s_{jt}$ 's) to construct a county level of the predicted lending supply shock. For each county and year, we compute the weighted average of the estimated bank fixed effects, weighted by the bank's base period market share in that county<sup>18</sup>.

$$Shock_{it} = \sum_j share_{ijt-1} \times s_{jt}$$

Where  $share_{ijt-1}$  is the bank  $j$ 's market share in county  $i$  in the year prior to the estimated shock<sup>19</sup>.

Once the instrument is computed, the summary statistics show a little variation over time, as presented in table 3. As shown in Figure 8, while the values are centered on zero for most of the years, we can assume that there are normally distributed. We then use the predicted lending supply shock as an instrument to the credit supply shock.

## 5.2 Validation of instrument

The validation of the instrument depends on what exactly drives the credit supply shocks. This is to see why the origination of loans to households differs across counties in the same state. If the source of that heterogeneity is exogenous, then the instrument is valid.

### 5.2.1 Relevance of the instrument

The computed instrument must be strongly correlated to the supply of credit to households and meet the condition of exclusive restriction (Identification assumption). This is simply to make sure that the instrument can be used as a strong prediction of the change in the supply of mortgage.

We run the following regression:

$$\Delta \ln(L_t) = \beta_0 + \beta_1 \times Shock_t + \epsilon_t$$

As clearly shown in the table 4 below, the coefficient of interest, which is  $\beta_1$  is highly significative, and the  $F$ -statistic is very high, sign of a strong

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16. See Greenstone and Mas (2012)

17. The choice of that date is due to the availability of the data.

18. The weight takes into account the number of banks operating in the county each year which can be different).

19. The choice of the year prior to the shock is made to account for the exogenous variation of the county exposure to shocks.

correlation between the two variables.

**Table 4** : Validation of the instrument: Correlation with the growth of the mortgage origination

	(2008 – 2011)	(2008)	(2009)	(2010)	(2011)
Supply Shocks	0.208*** (0.025)	0.094** (0.090)	0.262*** (0.116)	0.983*** (0.186)	0.174*** (0.047)
Time FE	No	-	-	-	-
State FE	Yes	Yes	Yes	Yes	Yes
Obs	8600	2150	2150	2150	2150
R <sup>2</sup>	0.079	0.526	0.453	0.820	0.630
F-Stat	68.21	51.10	55.04	27.54	43.54

**Note:** This table analyses the relationship between our estimated mortgage supply shocks and the actual mortgage origination. The dependent variable is the growth of the mortgage. All regression include constant. Standard error are in parentheses. \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% level.

### 5.2.2 Omitted variables

One potential issue would be that the effect of credit supply shock on the consumption might be biased by other confounding - beside the demand - mechanisms. To address that, we regress the predicted lending shock computed above on several other variables. These variables include: Debt to Income ratio (DTI), Log Income, and Log of total debt (this includes the mortgage, the credit card debt and the student loans debt). The ideal situation would be the absence (or just a little) of any correlation, otherwise, the effect of the credit on consumption would be driven by some other factors and would need to be purged by the latter.

Table 5 gives the results. Columns (1) – (3) take each variable individually. Even though the total debt and the income are individually significant, the magnitude is almost null, which means that the variables almost are not correlated. When putting these variables together, even though the income and debt are significant, their magnitude is almost null. This means that the computed shocks do not pick up demand effect. We can be sure that we disentangled the supply shock from any confounding mechanism, the demand mechanism in particular.

Column (4) takes all the variables together. Even though the magnitude of the coefficients are very small, the time fixed effect accounts for 60.49% of the variation of the supply shock. When the county fixed effects are added, both of these variations account for 70% of the variation of the supply shock. This shows that the computed shock does not pick up demand effects. To see whether the estimates pick up time trend or not, we run the last regression (Column (4)) for each year from 2008 to 2011. The results are shown in the

Table 6. It is shown in that table that there is not a time trend effect, because the coefficient are almost null and for the most part non significant.

## 5.3 Results

### 5.3.1 Baseline results

The results below are from the benchmark model (1). The control variable that we used here is the change of income from the IRS database. The choice of the variable is justified by its ability of having an effect on the consumption growth. The theories of consumption stress the income as a determinant of the consumption habits. the dependent variable is the change in consumption, the income variable should also be taken as a change. The income chosen here is the Adjusted Gross Income per return which is the average taxable income per habitant in the county<sup>20</sup>.

For us to control for the time fixed effect, we run the baseline regression year by year to see if there is a time-trend in the effect of mortgage supply shock on the consumption.

The results are clustered by states. This is to see whether the belonging to one state or another can influence the effect of the mortgage on consumption.

Therefore, for each of those years, we control for the state fixed effects, and we cluster by state. The positive coefficient indicates that the destination counties that experienced the larger decline in the supply of the mortgage exhibit lower consumption growth rate. A positive sign simply shows that the counties that experienced large decline in the supply of mortgage had the lowest consumption growth rate. The aggregate consumption was really affected mostly on 2009 and 2010.

Grouping counties by state also gives us some homogeneity regarding the difference of consumption growth between two counties that are one standard deviation apart in the origination of mortgage. Overall, in 2009 and 2010, for 2 counties that are 1 standard deviation apart in the origination of mortgage, the differences in consumption growth between both are 0.051 and 0.036 percentage point respectively<sup>21</sup>.

This is a noticeable result considering that the consumption habits and the lending activity is not the same from one state to another. The magnitude is higher in 2009 and 2010 as expected, because those are the years were the crisis were more severe. This can be explained by the repayment that the consumers have to face. As seen in the theoretical model, there is a substitution between the housing consumption and the non-durable goods consumption; because the consumers have decided to invest in housing, they now have

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20. This can count as a proxy of the average income in the county.

21. These results come from the formula:  $\frac{Std\_Shock}{Std\_Consumption} * \beta$

to reduce their consumption to face the repayment which exhibits the lower consumption growth.

Figure 9 presents the evolution of those effects throughout the time. As just documented above, the impact on the reduction of the consumption were very high in 2009 and 2010. The lower impact in 2011 is due to the post crisis.

Now that the effect of the mortgage shock on the consumption is defined in the previous section, one question that one can ask is to know what drives this effect. We mean the channel through that impact on consumption is driven. To that purpose, we listed some control variables correlated with the mortgage shock than can be the potential drivers of the effect. These are: the income heterogeneity (different income groups), the computed shock of the refinance, the credit card delinquencies, the mortgage delinquencies, and the Debt to income ratio.

### 5.3.2 Income Heterogeneity and impact on the consumption

This subsection analyses the income heterogeneity as a potential channel through the shock on a mortgage impacts the consumption change. We use the same three groups defined in the previous section (bottom 25%, middle 50% and top 25%). We split the counties in three groups, and we compute the shocks in those groups. Then we run the following regression, year by year to avoid time trend effect:

$$\Delta \text{Log}(C_i) = \alpha + \delta_1 \times \text{Shock}25_i + \delta_2 \times \text{Shock}50_i + \delta_3 \times \text{Shock}75_i + \delta_4 \times X_i + \epsilon_i$$

where *Shock*25, *Shock*50 and *Shock*75 are the computed shocks in each income groups.

The results in Table 8 shows us what we expected, which is the lower income counties are more severely affected. This results goes along with the literature that says lower-income households are more vulnerable to adverse shocks than higher-income households. A better visualisation of this particular results is shown in figure 10. The main effect on the total consumption change is hardly driven by the effect on the lower income counties. This is an econometric result that solidifies the descriptives statistics above. It shows that the shock of mortgage to households can be attributed to the intensive margin. 2009 and 2010 were no exception for the different income groups and had the most severe economic consequences.

### 5.3.3 Mortgage refinance and impact on the consumption

As seen in the descriptive above, the mortgage refinance is the biggest component of the mortgage purpose in the data, beside the home purchase and the home improvement purposes. So, this might be fair to think that

the shock on the total mortgage could be driven mostly by the shock on the mortgage refinance. We use the same methodology of mortgage shock to compute an exogenous Refinance shock. This is, we disentangle the supply side and the demand components of that part of the mortgage, then use the exposure of each county to the same three lenders to compute the shock. We then add this variable to the benchmark model (1). That is, we run the following regression:

$$\Delta \text{Log}(C_{it}) = \alpha_i + \beta_t + \delta_1 \times \text{Shock}_{it} + \delta_2 \times \text{Mortg.Refinance}_{it} + \delta_3 \times X_{it} + \epsilon_{it} \quad (3)$$

We run the regression for each year to avoid time trend effect. The results are in Table 8.

As presented in the table, the coefficient of the refinance shock is positive and significant at 5%. This simply means a negative refinance shock has a negative impact on the consumption change.

The two particular years that catch our attention are 2009 and 2010. These results are somehow expected, considering that those two years were those where the crisis has made more damages.

Because we look at the channel that drives the effect on the consumption, we must look at the magnitudes of the coefficients of the mortgage shocks and compare them with those in table 7. From 2008 – 2010, the coefficient have considerably changed. They have dropped by almost half. This particular result goes along with the descriptives in Figure 1 where the mortgage refinance accounts for more than 50% in the total issuance of mortgage. We would expect that when it comes to the computation of the shocks, we would have approximately the same results. It attests that the impact of mortgage shock on the consumption is highly driven by the shock on the mortgage refinance.

#### **5.3.4 Mortgage and credit card delinquencies and impact on the consumption**

A delinquent mortgage is a home loan for which the borrower has failed to make payments as required in the loan documents (or contract). A mortgage is considered delinquent or late when a scheduled payment is not made on or before the due date. The data we have give us the percent of mortgage debt that are 90% plus delinquent; that is the mortgage repayment has been done more than ninety days past the due date.

We would expect that a county where there is a big jump of mortgage delinquency would have a large decline on its consumption if facing a mortgage shock, because they will be more likely to repay their debt by reducing more their consumption.

To attest whether the mortgage delinquency is a channel through which there is an effect on the consumption, we run the following the regression:

$$\Delta \text{Log}(C_i) = \alpha + \delta_1 \times \text{Shocks}_i + \delta_2 \times \Delta \text{Mortg.Delinq} + \delta_2 \times X_i + \epsilon_i$$

But in the data we find that: There is not real effect on the consumption, the magnitude is almost null, but there is also not a change on the effect of the mortgage shock on consumption (when comparing to the results on table 7). This could mean that this channel is not the one through which there is an effect of the mortgage shock on the consumption. Looking further in the analysis, we see that, this effect is not really surprising, because when we look at the descriptives statistics, we noticed that the mean is very low (below 5%), which means that, although the mortgage debt is high, only a low percentage of the mortgage debt is considered as delinquent. The credit card delinquency obeys the same definition and the same computation methodology as the mortgage delinquency.

The idea is that a delinquent household would have a a reduction of his current and future consumption if there happens to be a reduction in the offer of mortgage. Even in the case where there is no issuance of new mortgage, he will still reduce his consumption because of the payment of his debt that he has to honour.

To look at the credit card delinquency as a potential channel that drives the effect of the consumption, we run the the regression:

$$\Delta \text{Log}(C_i) = \alpha + \delta_1 \times \text{Shocks}_i + \delta_2 \times \Delta \text{Credit\_Card.Delinq} + \delta_2 \times X_i + \epsilon_i$$

As the mortgage delinquency, we have no effect on the consumption and the magnitude of the coefficient are almost null. Furthermore, the coefficients of the supply shocks are barely changed comparing to those in Table 7. This implies that the credit card delinquency is not a channel through which the mortgage shock would affect consumption.

As mentioned above, a mortgage delinquency is a non payment of the mortgage on a specific due date. Thus, a county that is delinquent can be considered as a constrained one<sup>22</sup>, because he has a debt he failed to pay; therefore, when households living in that county seek for a new mortgage, because the county already has a bad credit report, there is sort of a systemic risk (that everybody faces) that they would face difficulties repaying the mortgage. They will not be provided with the loan as he required. He might get a fraction of what he asked or in the worst case, nothing. So, one

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22. Mortgage delinquency is taken as a proxy of the constrained agent

concern is to see whether a previously county reacts strongly to a mortgage shock or not. To test that hypothesis, we split the counties into 3 equal groups using the lag value of the mortgage delinquency: Low, Moderate and High delinquent; we assign a dummy variable to each group and we interact it with the mortgage shock. We run the following regression:

$$\Delta \text{Log}(C_{it}) = \delta_1 \cdot \text{Shocks}_{it} \times \text{Low}_{it-1} + \delta_2 \cdot \text{Shocks}_{it} \times \text{Mod}_{it-1} + \delta_3 \times \text{Shocks}_{it} \times \text{High}_{it-1} + \delta_4 \times X_{it} + \epsilon_{it}$$

where,  $\text{Low}_{it-1}$ ,  $\text{Mod}_{it-1}$  and  $\text{High}_{it-1}$  are the dummies for Low, moderate and high delinquent county the year before, respectively.

The results are consigned in Table 13. As expected, the high delinquent counties react differently and strongly from the low and moderate ones, although all the coefficients were not significant. In 2009 in particular the coefficient of the high delinquent counties is significant at 1%, this is the time where the crisis was the most severe and high delinquent counties of 2008 were very affected and reduced their consumption expenditures more than the others. In 2011, we see the same phenomenon even though the consumption expenditures were not reduced as much as they were in 2009. This can be explained with the argument that this is the aftermath of the crisis. The low and moderate delinquent counties cut off their consumption expenditures as well, but the cut off were not significant.

## 6 Conclusion

The 2008 crisis has had severe consequences on the global financial system and different economies as well. As far as the economic field is concerned, many studies pointed the fact that several damages were caused, from the consumption, to investments, to public finance, etc.

The goal of this paper is to point out a new methodology that focuses on one particular aspect of the crisis, the supply of the mortgage shocks, and looked at the repercussions on the non housing consumption. The study addresses both a theoretical model and an empirical model. Both approaches converge to the same conclusion, which is a reduction of the consumption following an adverse mortgage supply shock. The households with low income (more constrained) were the most affected.

The theoretical model was an important part of this study, simply because it lays out a simple framework on how an adverse shock could have an impact on the non housing consumption, and to point out some heterogeneity with regards to their income. I then used the theoretical model developed by

John Mondragon to compute the supply side of the reduction of the mortgage issuances.

As for the empirical study, I took the data from diverse sources (HMDA, NyFed, Nielsen, IRS) from 2008 to 2011. I first computed the supply mortgage shock using the theoretical methodology at the county level, and validated it through several tests and regressions. Then I run the main regression to look at the average effect on consumption, and clustering counties by state. This is because we think that counties in the same state behave almost the same way, or will be affected at least in a similar way. The main finding is that a negative shock of mortgage issuance (we can view it as the reduction of issuance of mortgage) reduce the consumption, as well as an expansion will increase it. The result is not the same for each year. I found that in 2009 and 2010 the counties were the most affected, because it was the same years where the crisis was the most severe.

Fast forwarding to the channel that drives the effect on the consumption, I selected four main factor that could potentially be the driver: Mortgage Delinquency, credit card delinquency, Income heterogeneity and Mortgage refinance. I found that the main channels are the mortgage refinance shock and the income heterogeneity. Low income counties are more vulnerable when they face adverse shock than high income ones. This testifies somehow of the resilience of high income counties and their ability to cope with the idiosyncratic risk than the low income ones. I also found that the other driver is the mortgage refinance shock, which accounts approximately for half of the effect on the consumption. On the other hand, the results show the mortgage and credit card delinquency not to be considered as driver of the effect, since they are not significant. Furthermore, the previous high delinquent counties tend to cut more their actual consumption expenditures following an adverse shock than the low and moderate delinquent counties, especially in 2009 and 2011.

This paper shed some new light and different mechanism through which the crisis has affected the real economy in the United States.

# APPENDIX A: THEORETICAL RESULTS

## Proof of the Proposition 3.1

The problem to solve is:

$$\begin{aligned} \max_{m,h} \{ & V(C) = u(y_1 + m - p.h, h) + \beta u((1 - \delta).p.h + y_2 - (1 + r)m, h) \} \\ \text{sc:} & 0 \leq m \leq \theta.p.h \end{aligned}$$

The utility function is:  $u(c, h) = \ln(c) + \alpha \ln(h)$ .

In this case, the Kuhn Tucker conditions provide  $\lambda = 0$  (the lagrange multiplier) and the first order conditions are:

$$\begin{aligned} \begin{cases} c_2 = \beta(1 + r)c_1 \\ (1 + \beta)\frac{\alpha}{h} - \frac{p}{c_1} + \frac{\beta p(1-\delta)}{c_2} = 0 \\ c_1 + ph - y_1 - m = 0 \\ c_2 + (1 + r)m - y_2 - (1 - \delta)ph = 0 \end{cases} & \Rightarrow \begin{cases} c_2 = \beta(1 + r)c_1 \\ (1 + \beta)\frac{\alpha}{h} - \frac{p}{c_1} + \frac{\beta p(1-\delta)}{c_2} = 0 \\ c_2 + (1 + r)(c_1 + ph - y_1) - y_2 - (1 - \delta)ph = 0 \end{cases} \\ & \Rightarrow \begin{cases} (1 + \beta)\frac{\alpha}{h} - \frac{p}{c_1} + \frac{(1-\delta)p}{(1+r)c_1} = 0 \\ \beta(1 + r)c_1 + (1 + r)(c_1 + ph - y_1) - y_2 \\ -(1 - \delta)ph = 0 \end{cases} \\ & \Rightarrow \begin{cases} (1 + \beta)\frac{\alpha}{h} - \frac{[(1+r)-(1-\delta)]p}{(1+r)c_1} = 0 \\ (1 + r)(\beta c_1 + c_1 + ph - y_1) - y_2 - (1 - \delta)ph = 0 \end{cases} \\ & \Rightarrow \begin{cases} (1 + r)(1 + \beta)\alpha c_1 = ph(r + \delta) \\ (1 + r)(1 + \beta)c_1 + (1 + r)(ph - y_1) \\ -y_2 = (1 - \delta)ph \end{cases} \end{aligned}$$

The combination of the last 2 equations give:

$$\frac{ph}{\alpha}(r + \delta) + (1 + r)(ph - y_1) - y_2 - (1 - \delta)ph = 0$$

which drives to:

$$h = \frac{(y_2 + (1 + r)y_1)\alpha}{(r + \delta)(1 + \alpha)p}$$

To find  $c_1$ , we go back to the equation  $(1 + r)(1 + \beta)\alpha c_1 = ph(r + \delta)$  and find:

$$c_1 = \frac{y_2 + (1 + r)y_1}{(1 + r)(1 + \beta)(1 + \alpha)}$$

We use the equation  $c_2 = \beta(1+r)c_1$  to find:

$$c_2 = \frac{\beta(y_2 + (1+r)y_1)}{(1+\beta)(1+\alpha)}$$

The mortgage demand is derived from the equation  $c_1 + ph - y_1 - m = 0$ . We plug the value of  $c_1$  found above and obtain the expression:

$$m = \frac{(y_1(1+r) + y_2)(r + \delta + \alpha(1+r)(1+\beta))}{(1+r)(1+\beta)(1+\alpha)(r+\delta)} - y_1$$

The demands functions of the non constrained borrower are<sup>23</sup>:

$$\begin{cases} c_1 = \frac{y_1(1+r)+y_2}{(1+\alpha)(1+r)(1+\beta)} \\ c_2 = \frac{\beta(y_1(1+r)+y_2)}{(1+\alpha)(1+\beta)} \\ h = \frac{(y_1(1+r)+y_2)\alpha}{p(r+\delta)(1+\alpha)} \\ m = \frac{(y_1(1+r)+y_2)(r+\delta+\alpha(1+r)(1+\beta))}{(1+r)(1+\beta)(1+\alpha)(r+\delta)} - y_1 \end{cases}$$

## Proof of the Proposition 3.2

Let's recall that the initial problem to solve is:

$$\max_{\{c_1, c_2, m, h\}} V(C) = u(c_1, h) + \beta u(c_2, h)$$

$$\text{sc: } \begin{cases} c_1 + p.h = y_1 + m \\ c_2 + (1+r)m = (1-\delta).p.h + y_2 \\ 0 \leq m \leq \theta.p.h \end{cases}$$

When the agent/borrower is constrained he hits his constraint. The third equation in the constraint set becomes

$$m = \theta.p.h$$

, and his lagrange multiplier is strictly positive. We are not going to solve for the lagrange multiplier since it's not the main goal of the study. The concavity of the utility function ensures the existence of the solution. That solution must be feasible, meaning, should be solution of the system:

$$\begin{cases} c_1 + p.h = y_1 + m \\ c_2 + (1+r)m = (1-\delta).p.h + y_2 \\ m = \theta.p.h \end{cases}$$

---

23. The full resolution is in Appendix A

We finally get all the equation in terms of  $m$  and the parameters:

$$\begin{cases} c_1 = y_1 + \left(\frac{\theta-1}{\theta}\right)m \\ c_2 = y_2 + \left(\frac{1-\delta}{\theta} - (1+r)\right)m \\ h = \frac{m}{\theta \cdot p} \end{cases}$$

And the consumption growth as a function of the mortgage  $m$  is:

$$g_c = \frac{c_2}{c_1} = \frac{y_2 + \left(\frac{1-\delta}{\theta} - (1+r)\right)m}{y_1 + \left(\frac{\theta-1}{\theta}\right)m}$$

## Construction of the supply shock

In this section, we aim to construct a supply shock of the mortgage that the households face using a simple framework<sup>24</sup>. The goal is to provide a theoretical background of the Greenstone and Mas methodology that we use later on in this paper.

We consider the economy has  $I$  counties and  $J$  lenders. Each county has a representative consumer, whereas there will be no representatives lender, simply because, a lender has the possibility to lend to any given consumer, regardless his county. The agents solve the exact problem that we've developed above, but there are some differences.

- The first is that, we introduce a lender (or financial intermediary) and we define a contract between a lender and a borrower as given by the couple  $(m_{ij}, r_{ij})$  which are the amount of loan given to the household associated with the interest rate.
- On the lenders side, each of them face a cost function which takes the level of lending  $m_{ij}$  and the cost shifter  $c_j$  as inputs. That is,  $\sigma_{ij}(m_{ij}, c_j)$ . The interest rate - which results from solving the lender's problem - is of course a function of the level of lending and the cost shifter:  $r_{ij} = r_{ij}(m_{ij}, c_j)$ .
- Each lender can originate mortgage to any county, and solve a separate and static problem<sup>25</sup>.

The similarity with the previous model is:

- The mortgage demand by a county  $i$  from a lender  $j$  - which results from solving the consumer's problem - is a function of the interest rate  $r_{ij}$ , an

24. This has been well elaborated by John Mondragon (2014)

25. We consider the separable problem to simplify the estimations. One could instead decide to take into account a joint problem and look at the optimal lending a lender could give to different county at the same time. The problem is that it will complicate the estimation by introducing non linearities, although it would bring efficiency gains.

a demand shifter  $d_i$  (which also depends on the income, the wealth, taste, etc.). We therefore have  $m_{ij} = m^D(r_{ij}, d_i)$ .

We have the system of two equations that give the equilibrium:

$$\begin{cases} m_{ij} = m^D(r_{ij}, d_i) \\ r_{ij} = r_{ij}(m_{ij}, c_j) \end{cases}$$

It is useful to log-linearize these equations around an arbitrary point. This gives us (ignoring the error terms):

$$\begin{cases} \widehat{m}_{ij} = \epsilon_{ij}^{mr} \widehat{R}_i + \epsilon_{ij}^{md} \widehat{d}_i \\ \widehat{R}_i = \epsilon_{ij}^{rm} \widehat{m}_{ij} + \epsilon_{ij}^{rc} \widehat{c}_j \end{cases}$$

Where,  $\epsilon$  are the appropriate elasticities. Combining both equations gives the system:

$$\begin{cases} \widehat{m}_{ij} = \frac{\epsilon_{ij}^{rc} \epsilon_{ij}^{mr}}{1 - \epsilon_{ij}^{mr} \epsilon_{ij}^{rm}} \widehat{c}_j + \frac{\epsilon_{ij}^{md}}{1 - \epsilon_{ij}^{mr} \epsilon_{ij}^{rm}} \widehat{d}_i = \theta_{ij}^m \widehat{c}_j + \gamma_{ij}^m \widehat{d}_i \\ \widehat{R}_i = \frac{\epsilon_{ij}^{rc}}{1 - \epsilon_{ij}^{mr} \epsilon_{ij}^{rm}} \widehat{c}_j + \frac{\epsilon_{ij}^{mr} \epsilon_{ij}^{md}}{1 - \epsilon_{ij}^{mr} \epsilon_{ij}^{rm}} \widehat{d}_i = \theta_{ij}^r \widehat{c}_j + \gamma_{ij}^r \widehat{d}_i \end{cases}$$

The system above describes how supply side and demand side shocks manifest themselves in prices and quantity changes between lenders and borrowers. We will use that simple structure to understand how the supply-side shock to mortgage will be constructed.

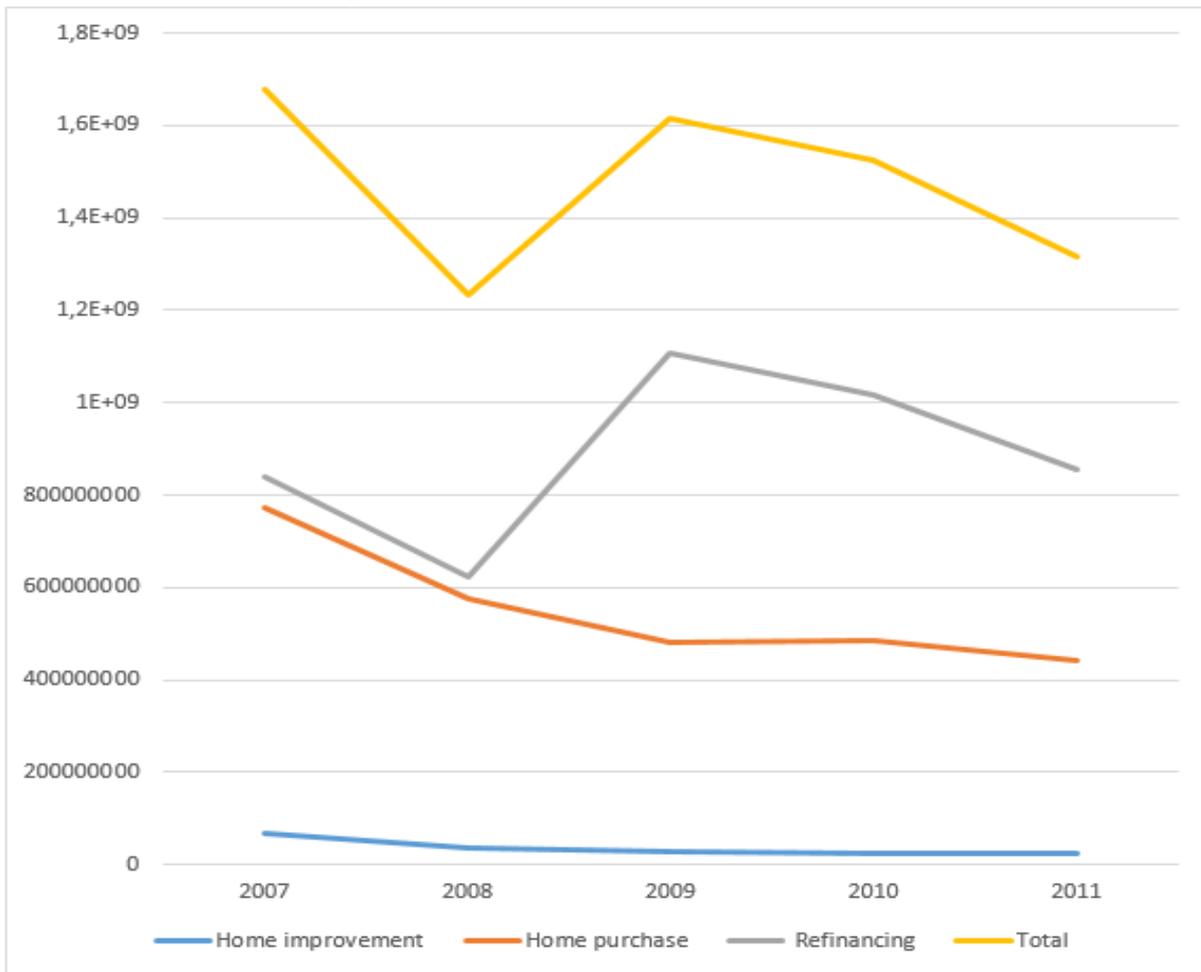
The following equation is the econometric specification that will be useful to empirically compute the supply shock:

$$\widehat{m}_{ij} = \theta_{ij}^m \widehat{c}_j + \gamma_{ij}^m \widehat{d}_i + \eta_{ij}$$

Before computing it, we need to address the issue of the source of our data and describe them.

## APPENDIX B: FIGURES AND TABLES

Figure 1 : Evolution of the loan issuance.



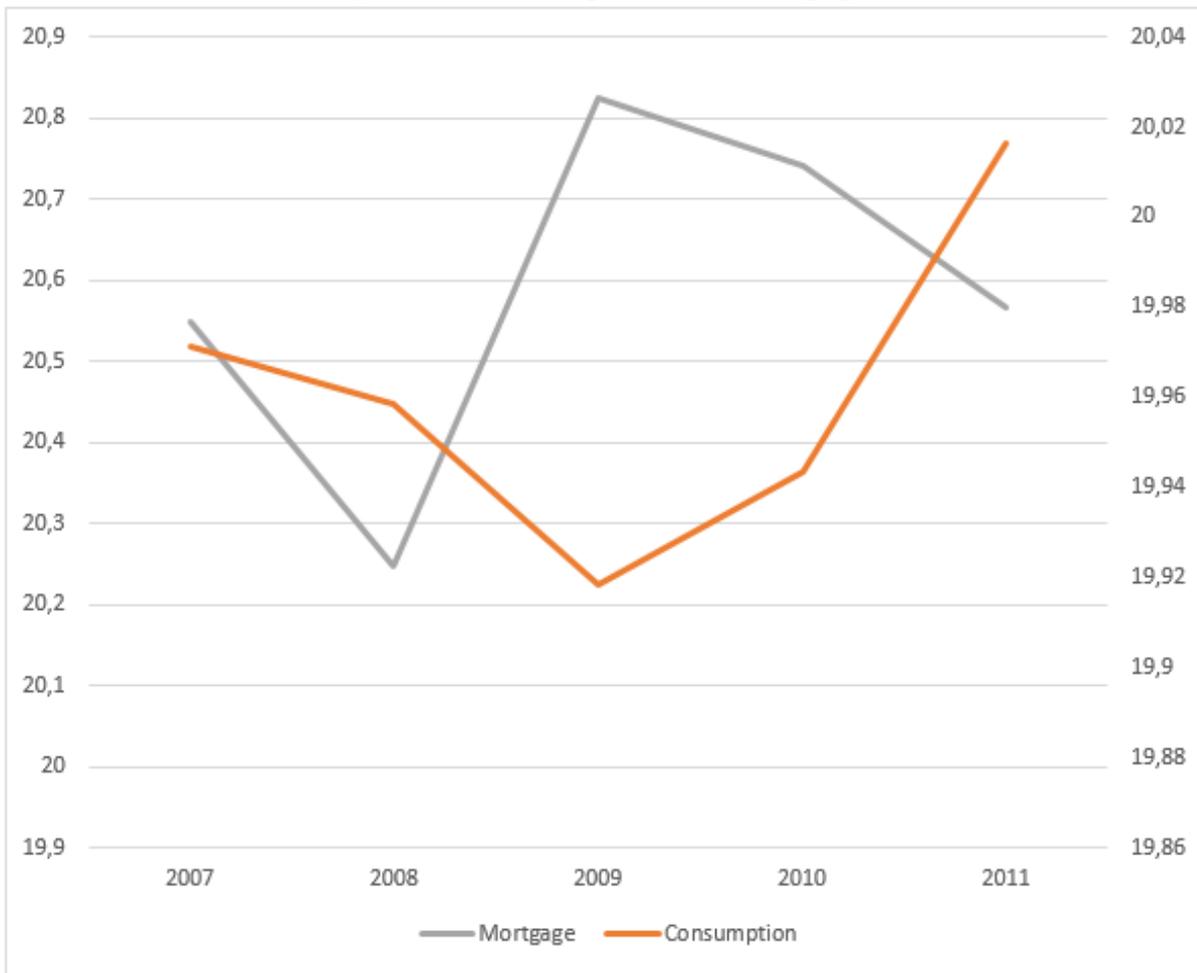
**Note:** The figure displays the evolution of the mortgage issuance for all the lenders in U.S.(Banks and mortgage companies) and the purposes of those loans from 2007 to 2011

**Figure 2 : Interest rate.**



**Note:** The figure presents a time series of the mortgage rate from 2007 to 2011. The data is monthly frequency.

**Figure 3 : Consumption and Mortgage.**



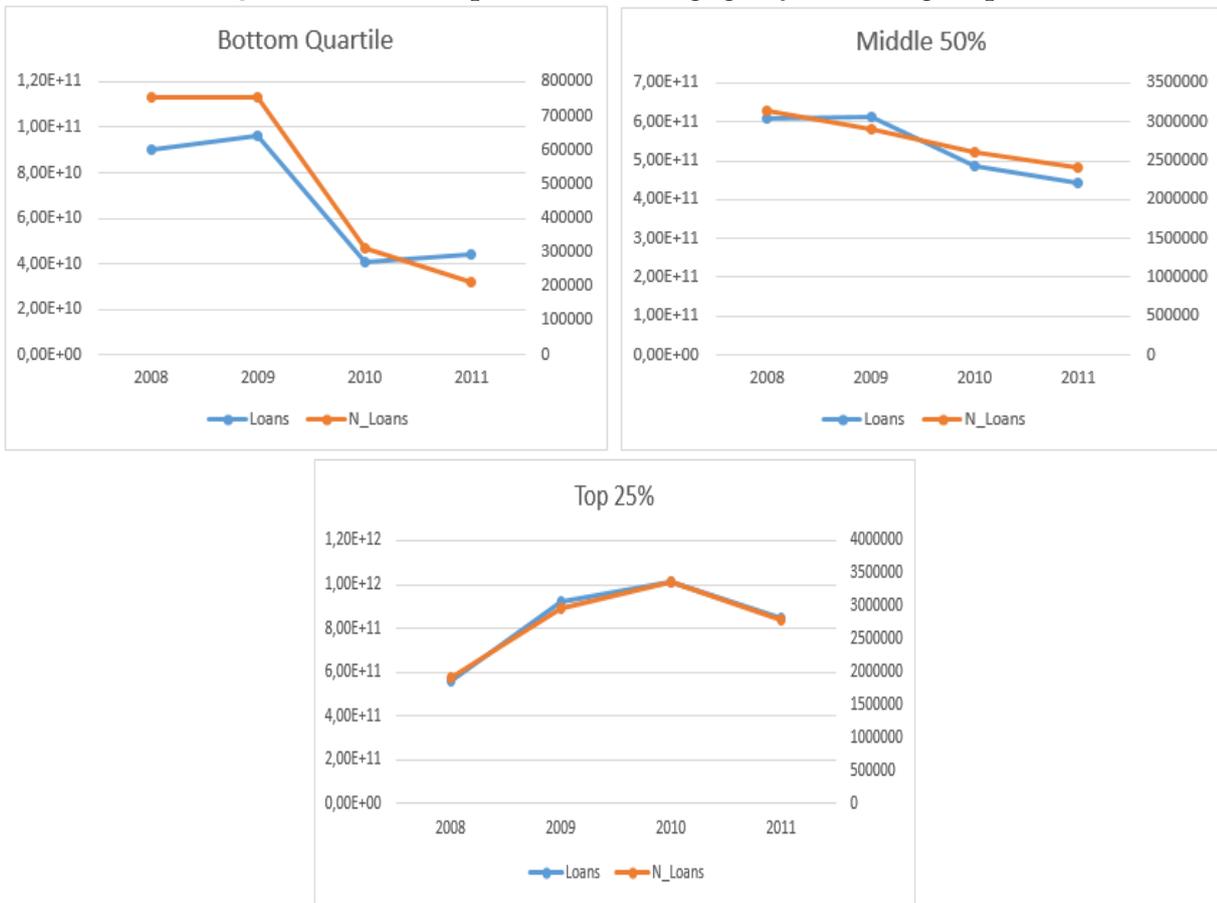
**Note:** The figure presents the comovement of the consumption and the mortgage. Mortgage is on the left axis and consumption is on the right one. The variables are taken in logarithm to reduce the scale.

**Figure 4 : Consumption and Mortgage by Income group.**



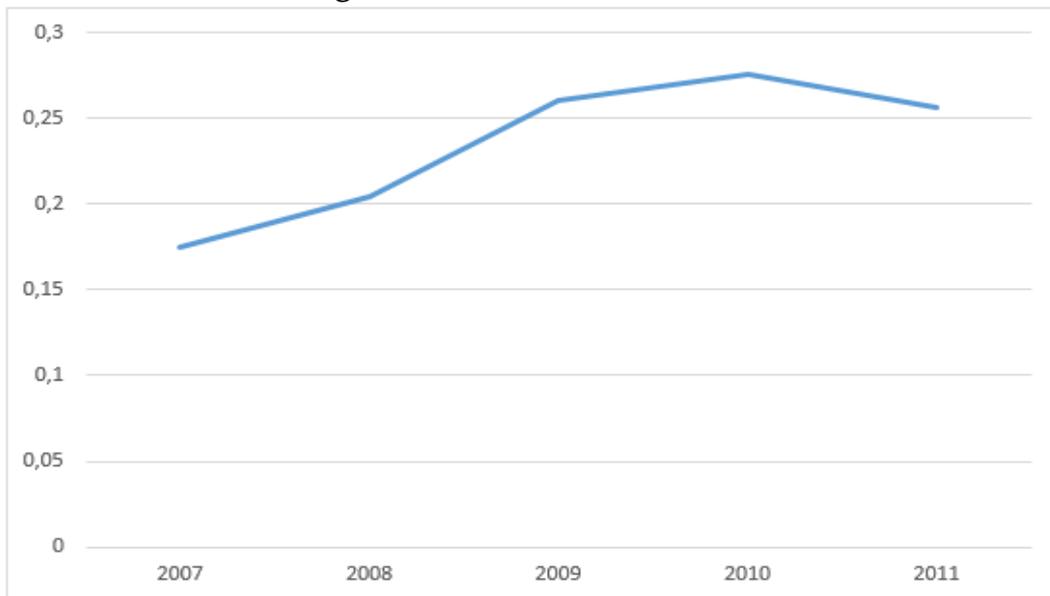
**Note:** The figure presents the comovement of the consumption and the mortgage by income group. The groups are created using the global value of income from 2007 to 2011. This shows the intensive margin of the issuance of the mortgage by county. Consumption is on the right axis and the mortgage is on the left axis.

**Figure 5 : Consumption and Mortgage by Income group.**



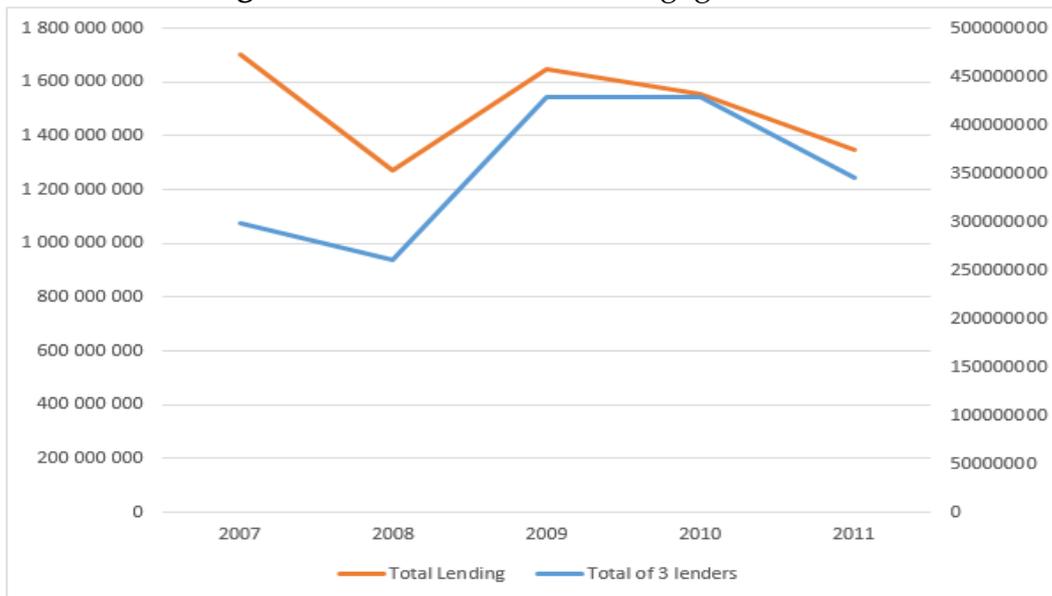
**Note:** The figure presents the comovement of the consumption and the mortgage by Income group. This shows the extensive margin of the issuance of mortgage by income. Number of loans in on the right axis and the amount of mortgage is on the left axis.

**Figure 6 : Share of the 3 lenders**



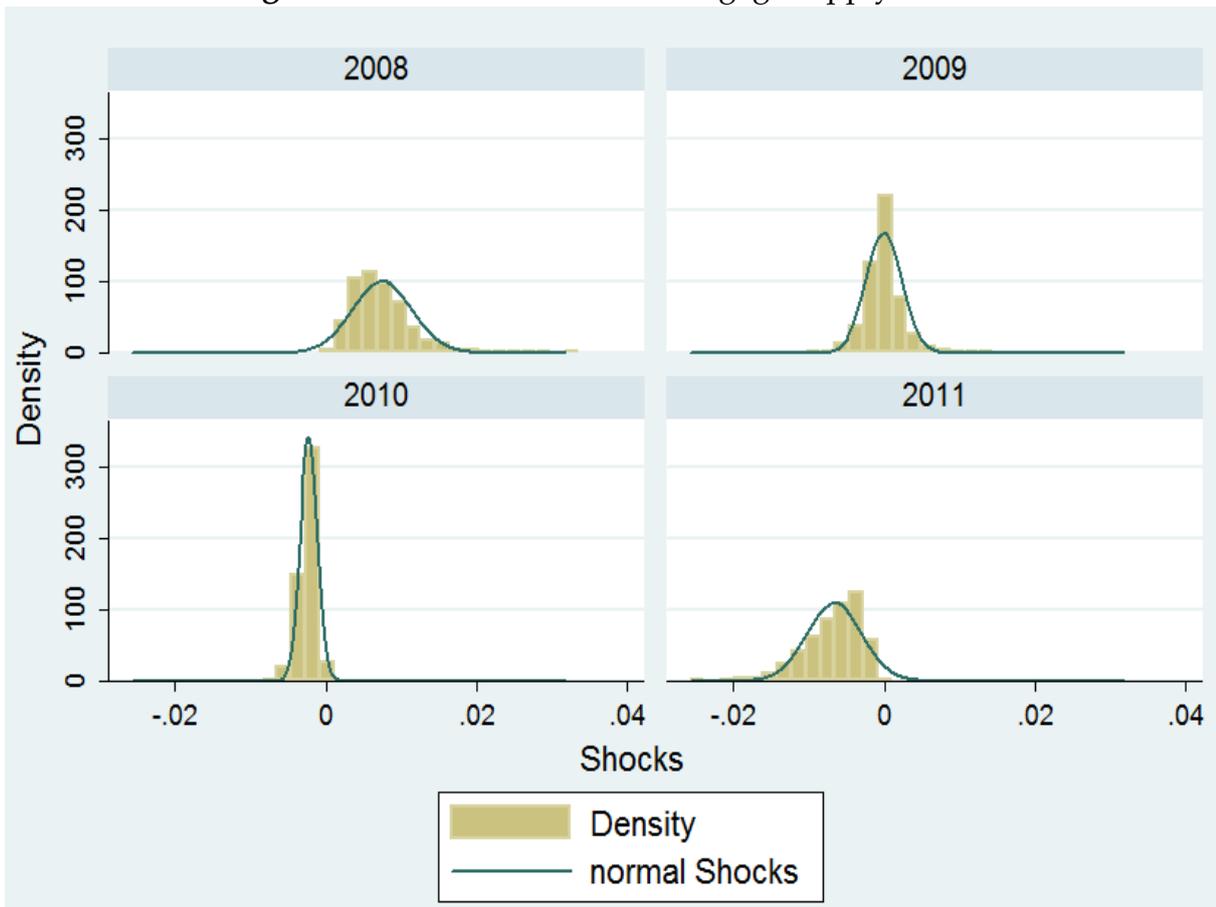
**Note:** The figure presents the share of the 3 lenders among 8,000 lenders each year from 2007 to 2011. These lenders are J.P. Chase Morgan, Bank of America and Wells Fargo.

**Figure 7 : Comovement of Mortgage Issuance**



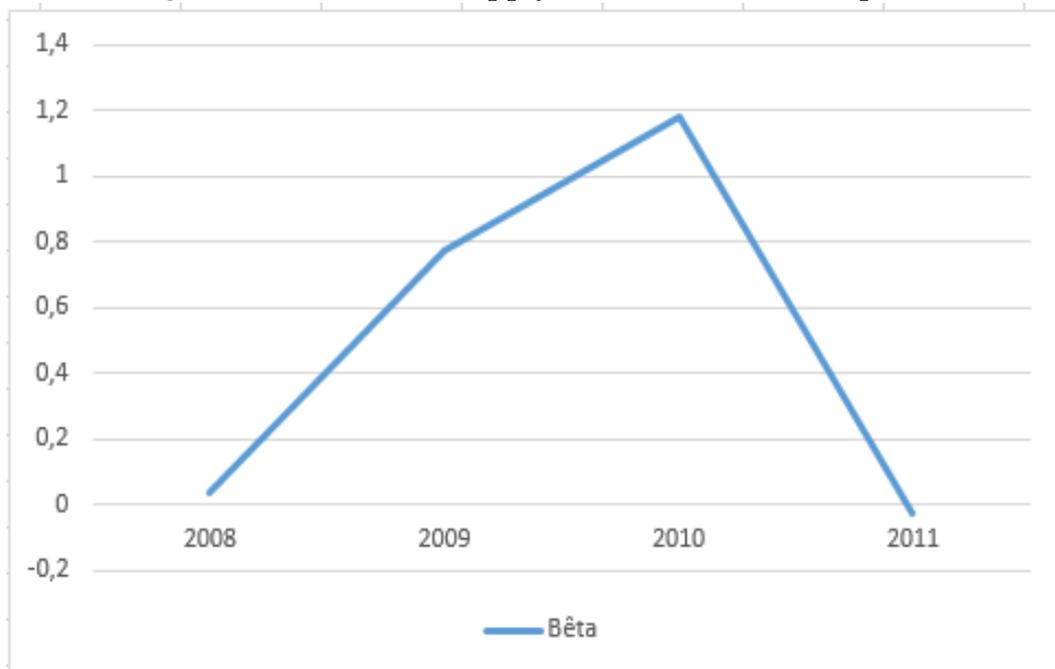
**Note:** The figure presents the comovement of the mortgage issued by the 3 lenders and by the all the lenders each year. The 3 lenders issuance is on the right axis and the total mortgage is on the left axis.

**Figure 8 :** Distribution of the Mortgage supply Shock



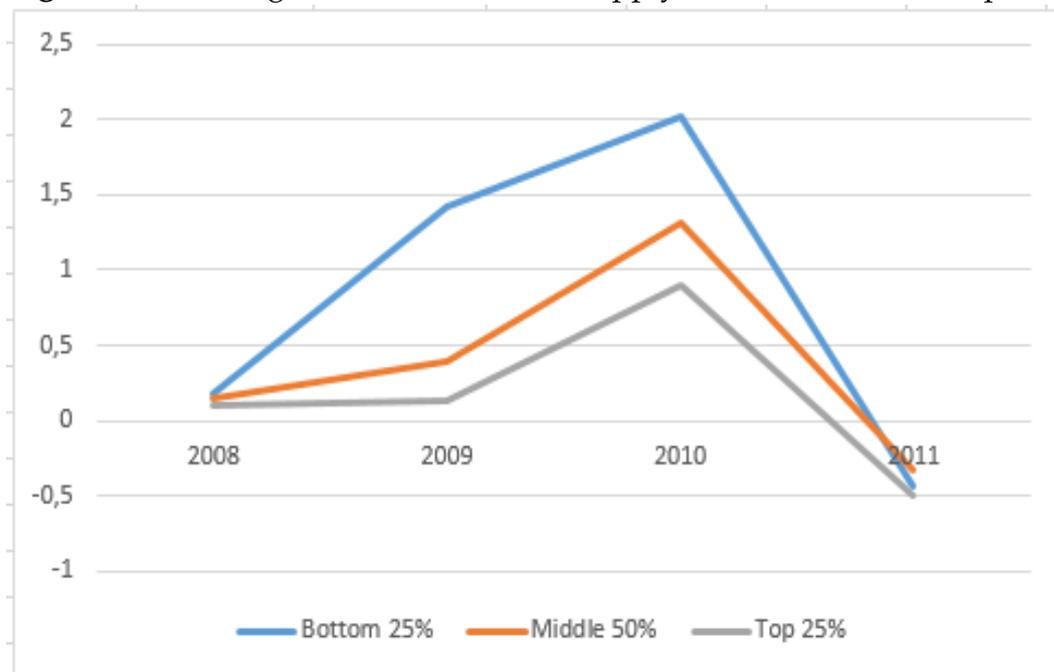
**Note:** The graph shows the histogram of the estimated mortgage supply shocks.

**Figure 9 :** Effect of the supply shock on the consumption



**Note:** The graph shows the evolution of the average effect of the mortgage supply shock on the consumption.

**Figure 10** : Heterogeneous effects of the supply shock on the consumption



**Note:** The graph shows the evolution of the average effect of the mortgage supply shock on the consumption in each income group.

**Table 1** : Summary statistics of consumption.

	<b>Mean</b>	<b>Std.</b>	<b>10%</b>	<b>25%</b>	<b>50%</b>	<b>75%</b>	<b>90%</b>
<b>2008</b>	-0.14%	3.01%	-2.82%	-1.13%	-0.13%	0.91%	2.69%
<b>2009</b>	-0.28%	3.63%	-3.10%	-1.47%	-0.34%	0.63%	2.12%
<b>2010</b>	0.21%	3.95%	-2.70%	-1.06%	0.12%	1.18%	3.28%
<b>2011</b>	0.47%	5.13%	-2.42%	-0.76%	0.40%	1.45%	3.34%

**Note:** This table shows the summary statistics of the aggregated consumption growth each year. It gives us which year was at first sight the worst in terms of the economic activity. It also gives more details to compare which percentile was more affected by the crisis.

**Table 2** : Summary statistics of consumption by Income group.

<b>Year</b>	<b>Bottom 25%</b>	<b>Middle 50%</b>	<b>Top 25%</b>
<b>2008</b>	-0.33%	0.15%	-0.08%
<b>2009</b>	-0.39%	-0.32%	-0.22%
<b>2010</b>	-0.20%	0.06%	0.34%
<b>2011</b>	0.50%	0.36%	0.57%

**Note:** This table computes the mean of the consumption growth by Income groups. It allows us to see if there is a substantial difference in each income groups.

**Table 3** : Summary statistics of computed shocks.

	<b>St.dev.</b>	<b>10%</b>	<b>25%</b>	<b>50%</b>	<b>75%</b>	<b>90%</b>
<b>2008</b>	0.40%	0.32%	0.46%	0.68%	0.94%	1.24%
<b>2009</b>	0.24%	-0.27%	-0.17%	-0.01%	0.10%	0.27%
<b>2010</b>	0.12%	-0.39%	-0.30%	-0.21%	-0.14%	-0.10%
<b>2011</b>	0.37%	-1.17%	-0.88%	-0.59%	-0.38%	-0.25%

**Note:** This table gives us brief statistics of the computed shock

**Table 5 :** Correlation of the mortgage supply shock and the omitted variables

	(1)	(2)	(3)	(4)
DTI	$-3.15e - 05$ (0.025)			$-2.10e - 06$ ( $1.97e - 06$ )
Total Debt		$-9.97e - 05^{**}$ (0.002)		$-1.37e - 04^{***}$ ( $4.6e - 05$ )
Log Income			$-1.14e - 04$ (0.0002)	$4.46e - 04^{**}$ (0.0001)
Time FE	Yes	Yes	Yes	Yes
County FE	No	No	No	No
Obs	8595	8600	8598	8593
$R^2$	0.742	0.742	0.741	0.742
F-Stat	142.37	141.70	144.01	97.80

**Note:** This table analyses the relationship between our estimated mortgage supply shocks and some county-level variables. The dependent variable is the mortgage supply shock. All regression include constant. Standard error are in parentheses. \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% level.

**Table 6 :** Correlation between the mortgage supply shock and county-level variables (year by year)

	(2008)	(2009)	(2010)	(2011)
DTI	$1.42e - 04$ ( $1.13e - 04$ )	$5.05e - 05$ ( $3.89e - 05$ )	$1.91e - 06^{***}$ $7.47e - 07$	$-1.03e - 04^{***}$ ( $3.61e - 05$ )
Total Debt	$-0.001$ (0.002)	$5.07e - 04$ ( $6.17e - 04$ )	$-8.3e - 04$ ( $1.87e - 04$ )	$-0.001^*$ ( $8.1e - 04$ )
Log Income	$0.001$ (0.002)	$-1.19e - 04$ ( $6.07e - 04$ )	$5.23e - 04^*$ ( $1.6e - 04$ )	$4.28e - 04$ ( $7.80e - 04$ )
Obs	2078	2078	2073	2078
$R^2$	0.038	0.095	0.191	0.223
F-Stat	3.06	6.73	35	34.02

**Note:** This table analyses the relationship between our estimated mortgage supply shocks and some county-level variables. The regression is done year by year. The dependent variable is the mortgage supply shock. All regression include constant. Standard error are in parentheses. \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% level.

**Table 7** :Average effect on the consumption

	(2008)	(2009)	(2010)	(2011)
Supply Shock	0.037*	0.771**	1.181**	-0.229
	(0.020)	(0.312)	(0.480)	(0.398)
$\Delta$ Income	-0.00064	-0.0283	0.012**	0.007
	(0.009)	(0.020)	(0.006)	(0.008)
State FE	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
Obs	2150	2150	2149	2149
$R^2$	0.255	0.266	0.262	0.164
F-Stat	10.01	21.48	25.29	0.58

**Note:** This table analyses the average effect of the mortgage supply shock on the non housing consumption. The regression is done year by year. The dependent variable is the change in non housing consumption. The results are clustered by State, to group the counties as much as possible. All regressions include constant. Standard error are in parentheses. \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% level.

**Table 8** :Income heterogeneity Channel

	(2008)	(2009)	(2010)	(2011)
Bottom 25%	0.185*	1.420**	2.022*	-0.432
	(0.105)	(0.565)	(1.070)	(0.502)
Middle 50%	0.155*	0.396*	1.312**	-0.328
	(0.085)	(0.220)	(0.520)	(0.400)
Top 25%	0.095**	0.135*	0.902*	-0.503*
	(0.385)	(0.081)	(0.485)	(0.260)
$\Delta$ Income	-0.003	-0.019	0.018*	-0.009**
	(0.005)	(0.004)	(0.010)	(0.004)
State FE	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
Obs	1952	1981	2004	2010
$R^2$	0.401	0.311	0.308	0.278

**Note:** This table analyses the heterogeneous effect of mortgage supply shock on consumption for each income group. We include the income heterogeneity to see whether it carries out some significant effects. The regression is done year by year. The dependent variable is the change in consumption. All regression include constant. Standard error are in parentheses. \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% level.

**Table 9 :Mortgage Refinance Channel**

	(2008)	(2009)	(2010)	(2011)
Supply Shock	0.015*	0.430**	0.412**	-0.120
	(0.009)	(0.206)	(0.169)	(0.880)
Refinance Shock	0.017*	0.352**	0.632**	-0.118
	(0.009)	(0.146)	(0.254)	(0.900)
$\Delta$ Income	0.0033	0.0079	0.007***	0.005*
	(0.003)	(0.040)	(0.002)	(0.003)
State FE	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
Obs	2150	2149	2149	2149
$R^2$	0.472	0.391	0.385	0.186
F-Stat	23.52	23.20	27.13	11.63

**Note:** This table analyses the relationship between our estimated mortgage supply shocks and the non housing consumption. We include the mortgage refinance shock to see whether it carries out some significant effects. The regression is done year by year. The dependent variable is the change in consumption. All regression include constant. Standard error are in parentheses. \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% level.

**Table 10 :Credit card delinquency Channel**

	(2008)	(2009)	(2010)	(2011)
Supply Shock	0.030	0.766*	1.176*	-0.236
	(0.282)	(0.400)	(0.710)	(0.405)
$\Delta$ Credit cards Delinq	0.0003	-0.0004	-0.0005	0.0004
	(0.0003)	(0.0002)	(0.0003)	(0.0003)
$\Delta$ Income	-0.0004	-0.0300	0.0130*	0.007
	(0.003)	(0.004)	(0.003)	(0.030)
State FE	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
Obs	2150	2150	2149	2149
$R^2$	0.0262	0.0256	0.0291	0.0166
F-Stat	0.74	12.19	24.01	0.39

**Note:** This table is a variation of Table 7 above. It analyses a potential channel through which the consumption might be affected. We include the change (in percentage point) in the credit card delinquency to see whether it carries out some significant effects. The regression is done year by year. The dependent variable is the change in consumption. All regression include constant. Standard error are in parentheses. \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% level.

**Table 11** :Mortgage delinquency Channel

	(2008)	(2009)	(2010)	(2011)
Supply Shock	0.039*	0.789*	1.201**	-0.230
	(0.281)	(0.463)	(0.854)	(0.411)
$\Delta$ Mortgage Delinquency	-0.0007	0.0015***	0.0009	0.0000
	(0.0004)	(0.0004)	(0.0004)	(0.0006)
$\Delta$ Income	-0.0014	-0.0260	0.0138**	0.0069
	(0.003)	(0.004)	(0.0068)	(0.003)
State FE	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
Obs	2150	2150	2149	2149
$R^2$	0.0277	0.0296	0.0286	0.0162
F-Stat	12.10	12.47	14.72	0.17

**Note:** This table is a variation of Table 7 above. It analyses a potential channel through which the consumption might be affected. We include the change (in percentage point) in the mortgage delinquency to see whether it carries out some significant effects. The regression is done year by year. The dependent variable is the change in consumption. All regression include constant. Standard error are in parentheses. \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% level.

**Table 12** :Delinquency heterogeneity effects on the consumption

	(2008)	(2009)	(2010)	(2011)
Low	0.034	0.236	0.288	-0.395
	(0.132)	(0.632)	(0.639)	(0.278)
Moderate	0.081	0.387	0.338	0.444***
	(0.194)	(0.558)	(0.960)	(0.133)
High	0.287	2.096***	0.554	0.717***
	(0.334)	(0.556)	(0.403)	(0.197)
$\Delta$ Income	-0.010	-0.014	0.007	0.007
	(0.008)	(0.011)	(0.010)	(0.010)
State FE	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
Obs	2150	2150	2150	2150
$R^2$	0.100	0.375	0.130	0.132

**Note:** This table analyses the heterogeneous effect of mortgage supply shock on consumption for each mortgage delinquency group. We include the mortgage status of the previous year to see if it carries a significant effect. The regression is done year by year. The dependent variable is the change in consumption. Standard error are in parentheses. \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% level.

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