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Book

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Household Spending Dynamics: The Impact of House Price-Rent Spread and Credit Constraints[*]

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ABSTRACT

This paper explores how fluctuations in the house price-rent spread influence household spending, taking into account credit constraints. We incorporate a housing spread shock, representing changes in the future value of residential property, into a model of household decisionmaking with borrowing frictions. Using half-century data from 28 OECD countries, we find that housing spread shocks are more persistent than credit shocks, which induce 'boom-bust' dynamics. We also identify asymmetries once the joint effect of shocks to housing spread and borrowing frictions is analyzed, particularly in crisis periods, underscoring the importance of policies addressing credit conditions and household expectations to stabilize the economy when traditional tools are less effective.

JEL Classification: D15, E21, E5, G51

Keywords: household expectations; house price-rent spread; credit frictions; interest rates; household consumption

1 Introduction

The global financial crisis of 2008-2009 placed the demand side and household balance sheet effects at center stage to account for the business cycles. More specifically, substantial aggregate consumption losses during that time were attributed to the credit liberalization and expansion as well as overly optimistic expectations about house prices (Piazzesi and Schneider, 2016; Guerrieri and Uhlig, 2016). Though there is a vast literature on consumption reactions to changes in (expected) house prices (e.g., Attanasio et al., 2011; Campbell and Cocco, 2007; Muellbauer and Murphy, 1997), there is less work on house price deviations from the fundamental value and its effects on consumption dynamics. We develop a simple theoretical framework, supported by empirical results, to analyze housing-related wealth, its effects on household expectations about future house prices and ensuing spillovers to the real economy. We do so by defining the *house price-rent spread shock*, which captures household expectations as the unexplained deviation between house price growth and rental rate growth. As we demonstrate, such deviation can be driven by multiple sources, such as quick and steep house price growth, rental price stagnation or household preferences about buying or renting the apartment. Moreover, we demonstrate that a spread shock brings asymmetric effects once it interacts with borrowing (credit market) frictions.

We endow a household sector with borrowing frictions, which helps us explore the role of credit and interest rate shocks. Our stylized model helps us link *expectations* about future house markets to the *house price-rent spread shock*. Deterioration of households' expectations leads to postponement of consumption, increased precautionary savings, drop in demand, and increased risk of a lower stream of future income. One of the benefits of our approach is that the key measure, the house price-rent spread, is readily available for many countries, unlike survey-based series that capture households' expectations or sentiments, but that use various formats and time frames, and are based on a range of methodologies. Using a simple theoretical framework, we demonstrate that the housing spread shock, observed for a sufficiently long period, is an informative and persistent measure of expectations regarding future house prices. An added value of our series is the long-time coverage – a half-century – and broad country coverage, 28 OECD countries overall.

Due to endogeneity, we first extract shocks to key variables of interest, namely, the house-rent spread and credit. Using a large panel, we find that an unexpected increase in the housing spread yields an extra stimulus and, in line with the theory predictions, increases the aggregate household consumption. This effect is persistent and lasts longer than the credit shock, which impacts consumption instantaneously only, confirming important qualitative differences in the two drivers of consumption dynamics. We also analyze the interest rate shock, separating domestic and US interest rates (the latter captures the global financial cycle's idea, as put forward by Rey (2015) and further documented by di Giovanni et al., 2021; Miranda-Agrippino and Rey, 2020; Rey, 2015; Lastauskas and Nguyen, 2023), documenting the 'boom-bust' episodes in household consumption. Though the literature has explored the impact of expectations, relatively little work has been done on combined effects between credit and household expectations concerning house prices (Attanasio et al., 2009, 2011).

Our key contributions to the literature and policy debates are the empirical confirmation of the importance of tracking not only house prices (Madsen, 2012), still a dominant approach, and credit conditions (Annicchiarico et al., 2019), but also joint dynamics, which help to capture expectations about house price changes as well as the *combined effect* between credit frictions and house spread shock, resulting in asymmetric impacts when shocks act together, particularly in crisis periods ('bad' states). Our emphasis on the role of housing spread shock in explaining consumption dynamics aligns with the findings of Kaplan et al. (2020). Specifically, Kaplan et al. (2020) demonstrate that the increase in the price-to-rent ratio (a gap between housing and rental prices) during the 2000s largely stemmed from household expectations regarding future house price growth. These expectations are believed to have stimulated household consumption. In our paper, we adopt an alternative framework to establish a connection between expectations of house price growth and changes in household consumption by using a house price-rent spread (housing spread for short) shock. Empirically, we demonstrate that shocks to the housing spread, reflecting these growth expectations, lead to consumption responses in the OECD sample. We also compare our results to the single-country evidence, linking to the existing literature, and country groups, exploring the role of country heterogeneity.

One important implication is that economic policies that tackle credit conditions (e.g., macro-prudential regulation) or expectations about future asset prices (e.g., forward-guidance) should be analyzed jointly due to existing co-movements and state asymmetries between the two forces driving consumption dynamics. More precisely, the house price-rent spread can respond to credit frictions; when acting together, credit and housing spread shocks produce a sizeable drop in consumption growth, lasting for a quarter, in the negative state (when the growth of both – credit and house spread shocks – is negative). The opposite (positive) effect on consumption is documented in the positive state as well, though it appears smaller than in the negative state (crisis), generating evidence for stronger recessionary impacts when credit and future house price expectations deteriorate simultaneously. Overall, our empirical exercise shows an asymmetric contribution of credit and housing spread shocks to the business cycle, warning policymakers to track housing spread and credit dynamics jointly to better target stabilization policies.

1.1 Household Balance Sheet

Our emphasis on housing is rooted in the well-documented household balance sheet effects. Over the past decades, financial asset prices have experienced significant swings and even some precipitous drops. As such, the literature concentrated on this side of assets but neglected another side: non-financial assets. The situation changed after the recent global financial crisis when house prices experienced a substantial decline and affected households' ability to consume in most advanced economies. Moreover, housing constitutes the largest asset class (see Figures 1.1 and 1.2) in the household balance sheets across developed countries. Figure 1.1 depicts household assets' decomposition in the United States based on the data from the Survey of Consumer Finances (SCF). By contrast, Figure 1.2 summarizes the situation in Europe by quoting Household Finance and Consumption Survey (HFCS) results. As is clearly evident, residential property remained the largest share of total household assets in the United States during the analyzed period of 30 years. A similar conclusion holds for European countries as housing plays a crucial role there as well. This first stylized fact provides us with a clear link between household wealth and current house prices.

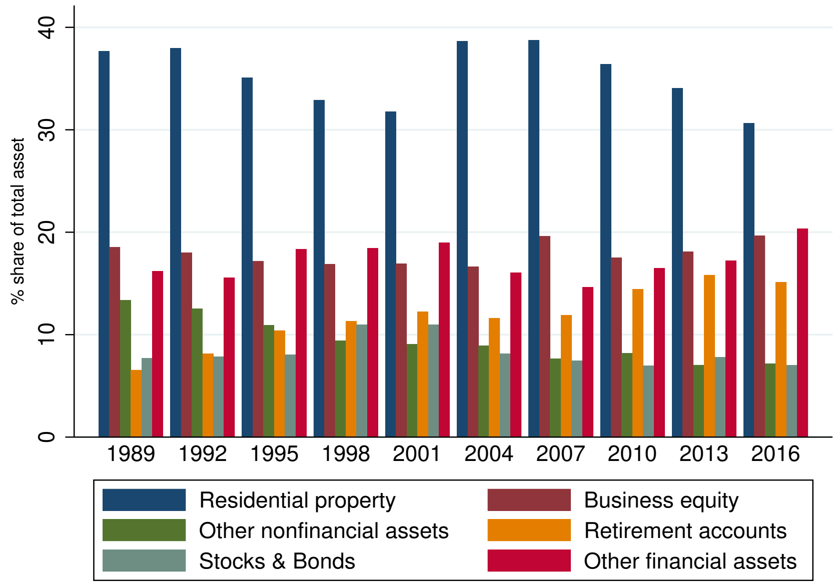


Figure 1.1: Household asset shares by asset classes in the United States

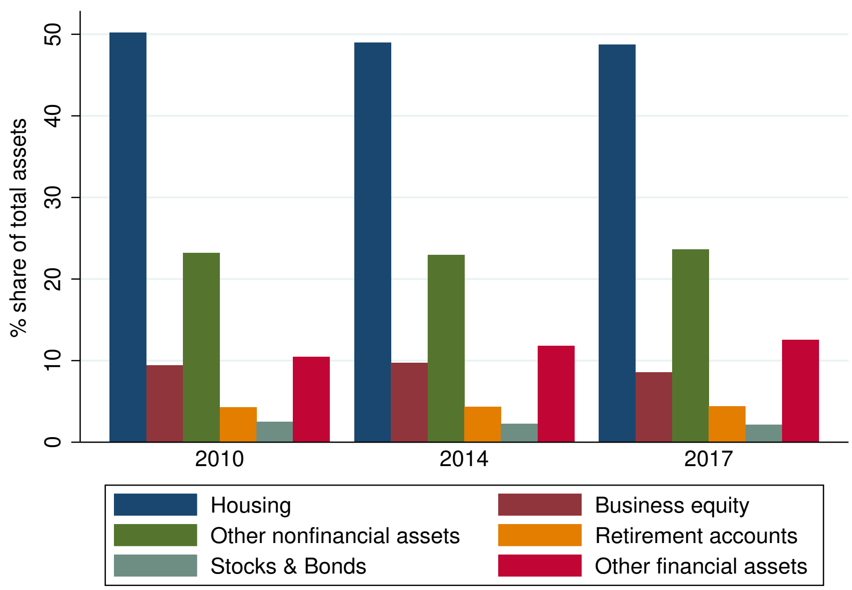
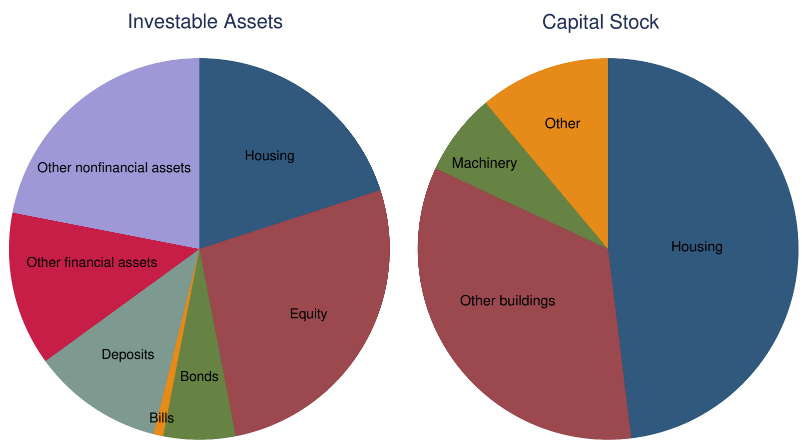


Figure 1.2: Household asset shares by asset classes in the Euro area

Moving away from household wealth, we also look at the decomposition of economy-wide investible assets and capital stocks in five major economies at the end of 2015: France, Germany, Japan, United Kingdom, and the United States (see Figure 1.3). The left panel of Figure 1.3 identifies the composition of investable assets, while the right-hand panel brings us the picture of capital stocks. Other asset categories outside the scope of the current study are: commercial real estate, business assets, agricultural land, corporate bonds, pension and insurance claims, and deposits. However, this does not constitute a real issue, as most of these assets represent claims of other assets as well. For instance, pension claims are usually invested in stock and bonds, while commercial property tends to co-move with residential property prices (Jordà et al., 2019). In sum, these empirical facts confirm the importance of housing and its price dynamics in household wealth analysis. Moreover, household consumption dynamics is governed by changes in wealth and expectations about its future value.



Note: Composition of total investable assets and capital stock. Average of the individual asset shares of major economies: France, Germany, Japan, United Kingdom, and United States, as of end-2015. Data are taken from national accounts and national wealth estimates published by the countries' central banks and statistical offices. *Source:* Figure I of Jordà et al., 2019.

Figure 1.3: Composition of investable assets and capital stock in the major economies

1.2 Related Studies

Given the empirical evidence, it is no surprise that a great deal of post-financial crisis literature identified household balance sheets as one of the key conduits for the materialization of the crisis and its transmission into the real economy. After a significant increase, house prices collapsed, triggering a financial crisis and a drop in household expenditures, which – in combination with macroeconomic frictions – led to a slump in employment (Mian et al., 2013; Mian and Sufi, 2014). The current literature identifies two main driving forces to explain 'boom and bust' episodes in house prices: credit conditions and beliefs about future housing demand (Kaplan et al., 2020). However, interactions between different shocks (e.g., credit), expectations regarding future housing value, and the real economy are still too under-researched to draw clear conclusions. This is so, despite the fact that policies affecting housing and credit markets play a key role in stabilizing or boosting the real economy, especially at times when standard tools, such as monetary policy, do not support the economy as much as intended. The recent financial crisis re-opened questions about macroeconomic modeling and the assumption of frictionless financial markets as neither the modeling nor the assumption served to anticipate the crisis or to analyze the disruption of credit markets (Gertler and Gilchrist, 2018).

The aggregate effects of household balance sheet on consumption dynamics during the 2008 financial crisis were documented by an influential set of papers by Mian et al. (2013); Mian and Sufi (2014, 2016). The authors found that low-income households in the United States increased their spending in line with a rise in house prices between 2002 and 2006, and faced a massive drop in income and consumption afterward. Housing comes into play as the low-income households liquefied their home equity during the house prices boom and increased their spending simultaneously. By contrast, high-income households barely changed their borrowing and spending behavior before the financial crisis. The result was that low-income households experienced significantly lower income and spending growth and a longer recovery period after the financial crisis materialized (Mian and Sufi, 2014). Recent IMF work (Caceres et al., 2019) supports the idea that housing is one of the most relevant forms of equity to affect consumption dynamics, at least judging from US household-level data. Against the background of other empirical studies, Kaplan et al. (2020) built a model with multiple aggregate shocks to generate fluctuations in equilibrium house price, and found beliefs to be the main driver for the shift in house prices. Based on their model, the 'boom-bust' in house prices explained half of the corresponding swings in non-durable expenditures in the United States over the past decades.

In addition to housing and households' expectations concerning house prices, the post-crisis literature also analyzed other shocks and their impacts on aggregate consumption and real economy fluctuations. Credit shock is a usual suspect as it affects borrowing constraints and gets transmitted into the real economy through changes in households' abilities to smooth consumption in the face of shocks. An individual credit data analysis in the United States identified a rapid mortgage credit expansion among low-income zip codes before the recent financial crisis. Liberalization of credit access was the dominant factor before the crisis, as it made it easy to borrow even for those households, which had previously found it difficult due to poor credit records or insufficient income (Amromin and McGranahan, 2015). Such a situation was particularly pronounced in mortgage lending, while other types of credit, particularly auto lending, were dominated by the business cycle movements (Amromin and McGranahan, 2015).

However, sentiments and expectations about the future state of the economy also played an important role in driving economic fluctuations. Unlike much of the current literature that concentrates on financial frictions in macroeconomics, López-Salido et al. (2017) suggested a behavioral view and argued that investors' sentiments in credit markets explain economic fluctuations. The key point is that current economic activity strongly influences expectations about future credit defaults. Specifically, investors become overly optimistic once they are influenced by good news about fundamentals, which leads to a situation in which credit spread narrows and the quantity of credit expands (López-Salido et al., 2017). This mechanism leads to endogenous reversals of sentiments as the later periods of further economic news will be disappointing compared to optimistic expectations. We emphasize the literature on sunspots and non-fundamental sources in causing economic fluctuations (Adam et al., 2011; Farmer, 2010, 2013; Levchenko and Pandalai-Nayar, 2020) since, as we will see, our main object of interest, housing spread shock, has substantial overlap with households' confidence.

Although the above-mentioned literature focuses on the interaction between housing and consumption, this paper highlights the behavioral aspect of households. It refers to the new and growing literature that analyzes how house price expectations are formed, how they affect households' behavior and how they are transmitted to their individual consumption decisions (Massenot and Pettinicchi, 2019). Recent literature has used different ways to target and analyze household expectations – through unconventional monetary policy (D'Acunto et al., 2022), tax policy (Martin et al., 2021), or expected economic outlook (Roth and Wohlfart, 2020). In addition, the literature shows that house price and housing cost expectations are one of the main factors to explain the general household expectations (Carroll et al., 2020; Piazzesi and Schneider, 2016). However, from an empirical point of view, it remains challenging to measure house price expectations at the aggregate level and to do so consistently across different countries. Our paper tries to fill this gap by proposing an empirical solution to analyze these issues across a larger number of countries. Finally, before jumping into the theoretical and empirical parts of the paper, it is important to address the issue of the (ir)rationality of expectations. While some papers have shown that some house price changes may be driven by irrationality (Hoffmann et al., 2012), others have found no evidence of behavioral biases in expectations related to individual housing tenure decisions (Gohl et al., 2024). Therefore, we adopt the traditional assumption of rational expectations, while keeping the main focus on a consistent empirical way to measure household expectations regarding house prices.

From a macroeconomic perspective, Mian et al. (2017) conclude that a rise in the household debt to GDP ratio is associated with a consumption boom followed by a reversal in the trade deficit since imports collapse, and that predicts a lower output growth and unemployment increase over the medium run. Numerous empirical studies employ sentiments and different other shocks, stemming from the household balance sheet, to explain aggregate consumption fluctuations. Recent literature on diagnostic expectations, which overweight future outcomes that become more likely in light of incoming data, indicate that these expectations are able to generate excessive volatility, overreaction to news, and predictable reversals (Bordalo et al., 2018).

Though a significant portion of the literature identifies house price expectation or credit shocks as the fundamental forces responsible for the slump in economic activity, mainly through changes in consumption and demand, the empirical focus remains on the U.S. or a handful of economies. We fill this gap by asking how housing market dynamics impact consumption smoothing and how the household expectation shock interacts with financial frictions in driving household consumption dynamics. To address this question, we analyze quarterly data from 28 OECD countries over a half-century period (1970 - 2020). Large cross-sectional and temporal dimensions enable us to shed new light on the determinants of household consumption. In particular, it has been challenging to assess external validity beyond the United States, having institutional and structural heterogeneities in mind. From the theoretical perspective, studies tend to model house prices, credit frictions, and changes in 'animal spirits' (Farmer, 2010, 2013) in isolation to explain macroeconomic movements. As covered above, the literature on housing and consumption contains relatively few applications of households' expectations about the worthiness of their houses. At the same time, credit and stock market shocks are analyzed more extensively through the lenses of sentiments and expectations.

Therefore, we contribute by analyzing housing spread shock-driven fluctuations in consumption, jointly with credit frictions. Our focus on the sources of credit shock as well as evidence on the credit-spread complementarities can help to formulate better-targeted and more effective economic policy.

The remainder of this paper is organized as follows. We motivate our empirical analysis with the theoretical model, which outlines how housing spread shock and borrowing frictions affect consumption dynamics in Section 2. We translate the main ideas into the empirical framework and conduct data-explanatory analysis in Section 3. Section 4 concentrates on the empirical findings and compares them with the current literature. Section 5 discusses extensions of the baseline model, covering the interest rate channel, the role of uncertainty, and cross-country heterogeneity, whereas Section 6 covers a set of robustness checks. Finally, Section 7 concludes and highlights some directions for future research, whereas the separate Online Appendix collects supporting evidence and more technical details.

2 Theoretical Motivation

Consider a simple environment of an economy where households draw utility from consumption C_t and housing services H_t (we abstract from disutility to work as under the standard additively separable utility function, it does not affect our key findings).[1] We are seeking to derive the relationship among consumption, credit, and housing. We stick to the rational expectations environment and explore whether such a simplified setting can give rise to empirically relevant dynamics. For now, we assume that uncertainty (and thus the use of the expectations operator) stems from the stochastic endowment, but we will be more specific about parametrization of stochastic processes later when it comes to exploring the role of uncertainty.

2.1 Households

The household welfare function is given by

$$\mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t} \left(\frac{(C_s)^{1-\nu}}{1-\nu} + \phi \frac{(H_s)^{1-\nu}}{1-\nu} \right), \tag{2.1}$$

where consumption C_t and housing services H_t are discounted by β and other features include isoelastic utility function with the elasticity of intertemporal substitution ν^{-1}, which, in this class of utility functions, also governs the coefficient of relative prudence; finally, $\mathbb{E}_t$ stands for the rational expectations operator. The lifetime welfare function is maximized subject to[2]

$$\begin{aligned} C_t + Q_t \left(H_t - H_{t-1} \right) + i_t B_{t-1} & \quad (2.2) \\ \leq B_t + Y_t, & \\ B_t \leq (1-\chi) Q_t H_t, & \quad (2.3) \end{aligned}$$

[1] The labor supply would then be pinned by the consumption path under given input prices (in our case, wages).
[2] Note that total wealth in our model is given by $W_t = Q_t H_{t-1} - i_t B_{t-1}$.

where (2.2) is the resource (budget) constraint, allowing for debt B_t, endowment (income) Y_t, house prices Q_t, and interest rates i_t on debt B_t. The borrowing constraint (2.3) à la Kiyotaki and Moore (1997) is such that, if a housing asset is purchased, a household can borrow at most $1-\chi$ of the house value. In other words, we assume a down-payment, equal to χ. Once $\chi \to 0$, the full nominal value of house can be used as collateral to expand debt, whereas $\chi \to 1$ implies that households have no access to the debt market.[3] As we are abstracting away from fully determining borrowing and lending, we will assume that $\chi \to 1$ implies that the house can be purchased from savings, stemming from the endowment (income) Y_t. We assume away the depreciation rate of the housing stock, which plays no substantial role for our results. We assume debt accrues interest rates i_t, exogenous from the household's perspective. One can think of interest rates as following a law of motion, similar to, for instance, Fernandez-Villaverde et al. (2011), specifying an international and country-specific component of the interest rate.[4] We will empirically explore a domestic interest rate controlled for domestic macroeconomic dynamics and the role of the US interest rate (capturing the global financial cycle and financially integrated markets case).

Finally, a relative share of housing services is governed by the parameter ϕ. In this stylized environment, the fact that markets are not complete due to the borrowing constraint is what generates a relationship between housing markets and consumption. In Appendix A.4.2, we cover requirements for the debt and no-Ponzi-game condition, as well as the rationale for why we do not need varying preferences β to justify positive or negative savings, which do not violate the transversality condition.

2.2 Optimality Conditions

The lifetime utility (2.1) maximization subject to constraints (2.2)-(2.3) delivers the following optimality conditions:

$$H_t^{-\nu} = \frac{1}{\phi}\left\{(C_t)^{-\nu} - \mu_t(1-\chi)\right\} Q_t - \frac{1}{\phi}\mathbb{E}_t\beta\,(C_{t+1})^{-\nu}\, Q_{t+1}, \tag{2.4}$$

$$\begin{aligned}\mu_t &= (C_t)^{-\nu} - \beta\mathbb{E}_t\,(C_{t+1})^{-\nu}\, i_{t+1} \\ &= (C_t)^{-\nu}\left(1-\beta\mathbb{E}_t\left(\frac{C_{t+1}}{C_t}\right)^{-\nu} i_{t+1}\right),\end{aligned} \tag{2.5}$$

where μ_t captures a shadow price of borrowing constraint (credit frictions). The equation (2.4) describes how housing services interact with house prices and consumption changes. Notice that there is one source of consumption smoothing – debt markets – as captured in the borrowing constraint (2.5). Using an endogenously determined borrowing with a collateral constraint, we can

[3]Note that $1-\chi$ in $B_t \leq (1-\chi)\,Q_t H_t$ can be interpreted as the loan-to-value ratio.

[4]Fernandez-Villaverde et al. (2011) embed stochastic volatility in the law of motion for real interest rates; instead, we will allow for observed uncertainty in the empirical exercise.

reduce the system (2.4)-(2.5) into:

$$H_t^{-\nu} = \frac{1}{\phi}\left\{\chi\left(C_t\right)^{-\nu} + \beta\left(1-\chi\right)\mathbb{E}_t\left(C_{t+1}\right)^{-\nu} i_{t+1}\right\} Q_t - \frac{1}{\phi}\mathbb{E}_t\beta\left(C_{t+1}\right)^{-\nu} Q_{t+1}, \tag{2.6}$$

We obtain housing services spending, linking a path of current and future consumption as well as house prices, encapsulating intertemporal consumption smoothing conditions. Housing demand clearly depends on consumption patterns, especially what is expected in the future, including future interest rates and future house prices (as captured by the terms $\mathbb{E}_t\left(C_{t+1}\right)^{-\nu} i_{t+1}$ and $\mathbb{E}_t\beta\left(C_{t+1}\right)^{-\nu} Q_{t+1}$. In other words, intertemporal consumption smoothing exemplifies the importance of expectations about the future, especially the path of interest rates and house prices for today's consumption of house services.

Last, to see how optimal consumption-housing choice gets determined, we can re-express (2.6) as

$$\begin{aligned} R_t^H = &\left\{\chi + \beta\left(1-\chi\right)\mathbb{E}_t\left(\frac{C_{t+1}}{C_t}\right)^{-\nu} i_{t+1}\right\} Q_t \\ &- \mathbb{E}_t\beta\left(\frac{C_{t+1}}{C_t}\right)^{-\nu} Q_{t+1}, \end{aligned} \tag{2.7}$$

where the rent (denoted by R_t^H) is given by the ratio of marginal utilities with respect to housing and consumption (an *intra-temporal* choice); given functional form in equation (2.1), it is equal to

$$R_t^H = \phi\left(\frac{H_t}{C_t}\right)^{-\nu}. \tag{2.8}$$

Using (2.7), the rent (fundamental) to house price ratio is driven by

$$\begin{aligned} \frac{R_t^H}{Q_t} &= \chi + \beta\left(1-\chi\right)\mathbb{E}_t\left(\frac{C_{t+1}}{C_t}\right)^{-\nu} i_{t+1} - \mathbb{E}_t\beta\left(\frac{C_{t+1}}{C_t}\right)^{-\nu}\frac{Q_{t+1}}{Q_t}, \\ &= \chi + \left(1-\chi\right)\left(1-\left(C_t\right)^{\nu}\mu_t\right) - \mathbb{E}_t\beta\left(\frac{C_{t+1}}{C_t}\right)^{-\nu}\frac{Q_{t+1}}{Q_t}, \end{aligned} \tag{2.9}$$

where we embedded a borrowing constraint (2.5). Unlike Berger et al. (2018) who assume a constant rent to price ratio in their study on consumption and house prices,[5] there are two forces in our setting that can make this ratio systematically change: shocks to the borrowing constraint and stochastically discounted growth rate of house prices, driven by, for instance, sentiments about the future housing market. It thus becomes clear that (2.7) and (2.9) demonstrate how house prices are related to fundamentals (R_t^H) and possibly speculative (bubble) yet rational components in house prices. To see the link more transparently, we first analyze an economy absent any borrowing frictions.

[5] There is empirical and theoretical literature showing that rent to price ratio is co-moving with fundamentals (Sommer et al., 2013) and the state of the economy, reflecting expectations of future housing returns (Favilukis et al., 2017).

2.3 Economy without Borrowing Frictions

Rearranging the demand for house equation (2.4) and imposing zero shadow prices of constraints, i.e., $\mu_t = 0$, we are led to the first result.

Proposition 1. *The house price, absent borrowing frictions, is equal to the rental rate and the expected discounted future price,*

$$\begin{aligned} Q_t &= R_t^H + \mathbb{E}_t M_t^{t+1} Q_{t+1} \\ &= R_t^H + \mathcal{S}_t, \end{aligned} \tag{2.10}$$

where $\mathcal{S}_t \equiv \mathbb{E}_t M_t^{t+1} Q_{t+1}$ stands for the house price-rent spread (note that in this particular case, $\mathcal{S}_t \equiv \mathbb{E}_t M_t^{t+1} Q_{t+1} = Q_t - R_t^H$).

Proof. The house price under no borrowing constraints follows from (2.4), setting $\mu_t = 0$, using (2.8), $M_t^s \equiv \beta^{s-t} (C_s/C_t)^{-\nu}$, and rearranging results in (2.10). □

Iterating (2.10) forward, one obtains a decomposition:

$$Q_t = \underbrace{\mathbb{E}_t \sum_{j=0}^{T-1} M_t^{t+j} R_{t+j}^H}_{\text{fundamentals (discounted rental rates)}} + \underbrace{\mathbb{E}_t M_t^{t+T} Q_{t+T+1}}_{\text{bubble term}} = F_t + \mathcal{B}_t, \tag{2.11}$$

where the stochastic discount factor (pricing kernel) is $M_t^s \equiv \beta^{s-t} (C_s/C_t)^{-\nu}$ for $s \geq t$, F_t is the fundamental price component (discounted rental rates) and $\mathcal{B}_t$ stands for the bubble component that violates the transversality condition. Such a decomposition has roots in Blanchard and Watson (1982): it is clear that for the rational bubble component to exist, its growth can *neither dominate nor be dominated* by the stochastic discount factor M_t^s. Consider perfect consumption smoothing, then $M_t^s = \beta^{s-t}$, and

$$\begin{aligned} Q_t &= \mathbb{E}_t \textstyle\sum_{j=0}^{T-1} (\beta\phi)^j \left(\frac{H_{t+j}}{C_{t+j}}\right)^{-\nu} + \beta^T \mathbb{E}_t Q_{t+T+1} \\ &= \mathbb{E}_t \textstyle\sum_{j=0}^{T-1} \beta^j R_{t+j}^H + \beta^T \mathbb{E}_t Q_{t+T+1}, \end{aligned}$$

therefore linking the bubble component to the time preference β and the relative weight of housing in the utility function. It is also true that the asset should be infinitely-lived for the bubble to exist as it would be terminated at its fundamental value at maturity, i.e., $Q_t = \mathbb{E}_t \sum_{j=0}^{\infty} \beta^j R_{t+j}^H + \lim_{T\to\infty} \beta^T \mathbb{E}_t Q_{t+T+1}$.[6]

However, as demonstrated by Allen et al. (1993), this is no longer true if agents' beliefs are heterogeneous since then they are not aware of others' beliefs. This opens the door to rational beliefs of selling a house (an asset) above the fundamental price if agents hold different beliefs; absence of common knowledge breaks the backward induction argument and therefore enables the

[6] To ease interpretation, further assume that house rent rate is time-invariant, i.e., $R_{t+j}^H = R_t^H$. It then follows that $Q_t = \frac{1}{1-\beta}\mathbb{E}_t R_t^H + \lim_{T\to\infty} \beta^T \mathbb{E}_t Q_{t+T+1}$, implying that the fundamental component is just a discounted rental rate, $\frac{1}{1-\beta}\mathbb{E}_t R_t^H$, and a bubble component, $\lim_{T\to\infty} \beta^T \mathbb{E}_t Q_{t+T+1}$, which may not be equal to zero due to the violation of the transversality condition in the infinite horizon setting or under heterogeneous beliefs even in the finite horizon setting.

bubble's existence even in the *finite horizon environment*. This idea justifies why shocks to the deviation between house prices and rental rates contain information about households' held beliefs and sentiments about the housing market. The idea that heterogeneity is sufficient to generate rational bubbles even for finitely-lived assets implies that the decomposition into fundamental and bubble components can be used for empirical strategy.

To make this operational, we will denote a house price-rent spread variable as $\mathcal{S}_t \equiv Q_t - R_t^H$, defined as a disconnect of house prices from the rental rates in the case of no borrowing frictions. Absent borrowing frictions, Proposition 1 tells that $\mathcal{S}_t$ enters the bubble component that might violate the transversality condition in the limit. We will use the decomposition of house prices to base our empirical strategy. However, we do *not* take a stance on the nature of the belief shock: in fact, it can be intrinsic or extrinsic (Cass and Shell, 1983). An example of an intrinsic shock is dependence of the bubble component on rent, as proposed by Froot and Obstfeld (1991).[7] Alternatively, there may be a reason outside the model (fundamentals) that makes the bubble component move (so-called extrinsic uncertainty or sunspots).

A belief or general bubble component-driven change in house prices may thus be self-fulfilling (Azariadis, 1981). It can be that agents hold expectations about future house prices, as they are external variables to them (they choose housing consumption but take price as a given) as in Adam and Marcet (2011). The authors show that the equilibrium asset price is then pinned down by investors' expectations of the price and dividend in the next period, not by expectations of the discounted sum of dividends.

Another recent stream of literature deviates from the rational expectations framework and introduces so-called that become more likely in light of incoming data, thus giving rise to excessive volatility, overreaction to news, and predictable reversals (Bordalo et al., 2018). All in all, we will remain agnostic about deep sources of systematic house price deviations from rental rate, but we will stick to rational expectations and explore their relationship with main "suspects", as just discussed: households' sentiments and household heterogeneity in terms of propensities to consume (the so-called "hand-to-mouth" consumers).

2.4 Economy with Borrowing Frictions

To help us structure our empirical exercise, we shall now bring back the borrowing frictions. We start deriving house prices provided the borrowing frictions are binding.

[7] Suppose a bubble component is given by $\mathcal{B}_t \equiv c\left(\frac{H_t}{C_t}\right)^{-\nu\lambda}$, then $dQ_t/d\left((H_t/C_t)^{-\nu}\right) = \beta + c\lambda\left((H_t/C_t)^{-\nu}\right)^{\lambda-1}$. The price-rent may systematically deviate if the bubble component exists; this observation led Froot and Obstfeld (1991) to suggest a cointegration test as the means to determine the existence of intrinsic bubbles. That is why we consider the spread variable as the driver of consumption dynamics, rather than house prices or rental rates separately, as is often considered in the literature (Adam et al., 2012; Beltratti and Morana, 2010; Iacoviello, 2004).

2.4.1 House Prices

The use of the borrowing constraint gives rise to the updated housing price, that is, instead of (2.10), which is $Q_t = R_t^H + \mathcal{S}_t$, we now obtain:

$$\begin{aligned} Q_t &= \{1 - \mu_t (C_t)^\nu (1-\chi)\}^{-1} \left(R_t^H + \mathcal{S}_t\right) \\ &= \underbrace{\left\{1 - (1-\chi)\left(1 - \mathbb{E}_t M_t^{t+1} i_{t+1}\right)\right\}^{-1}}_{\text{An amplification effect}} \left(R_t^H + \mathcal{S}_t\right), \end{aligned} \tag{2.12}$$

where the second equality follows after having incorporated the shadow price of the borrowing constraint (2.5). As before, the stochastic discount factor (pricing kernel) is given by $M_t^s = \beta^{s-t} (C_s/C_t)^{-\nu}$ for $s \geq t$.

Lemma 2.1. *The house price with borrowing frictions is equal to the rental rate and a housing spread (expected discounted future price), adjusted for the shadow price of the borrowing constraint and the loan-to-value ratio.*

Proof. By inspection of (2.12). □

In other words, a combination of Proposition 1 and Lemma 2.1 leads to a corollary that a bubble component, which is a discounted long-run non-zero spread term, can arise even absent the borrowing frictions, whereas a multiplier effect of the borrowing frictions on house prices can occur even though the spread component was time-invariant. For the time-varying bubble term to arise, we only require violation of the transversality condition or belief heterogeneity. For the amplification effect to operate, we require incomplete markets that deliver borrowing frictions. However, it is both channels, the time-varying spread component and borrowing frictions, that are of interest when exploring the impact of housing on the real economy.

That is why in our empirical exercise we will consider if the house price in (2.12) contains predictive power on the patterns of consumption, while simultaneously accounting for the expectations about house prices (the spread) and borrowing frictions. Notice that absent debt market, $\chi = 1$, there is no tradeoff between savings and debt to smooth consumption. What is more, along a balanced growth path, $M_t^{t+1} = \beta$, in which case, an additional assumption of the subjective discount factor β coinciding with the interest rate, $1/i_{t+1}$, would remove the effect of the borrowing constraint (but would retain the expectations' term about the future house prices, $\mathcal{S}_t$).

2.5 Household Consumption Spending

We now turn to the empirical implications of the household spending patterns. Rearranging the house prices with the borrowing frictions in (2.12), we obtain:

$$C_t = \underbrace{\left((1-\chi)\,\mu_t\right)^{-\frac{1}{\nu}}}_{\text{Borrowing (credit) friction}} \underbrace{\left(1 - \left(\frac{R_t^H + \mathcal{S}_t}{Q_t}\right)\right)^{\frac{1}{\nu}}}_{\text{Relative fundamentals and housing spread}}. \tag{2.13}$$

The first term captures binding credit-frictions, whereas the second term accounts for the relative fundamentals and spread shares in terms of the house prices. First, notice that the equation (2.13) makes it crystal clear that the impact of an exogenous change in house prices on consumption depends on the magnitude of the borrowing frictions constraint.[8] Since the shadow costs of borrowing and the spread contain forward-looking components (see (2.5) and (2.10)), we will explore their role in generating consumption patterns. In other words, as cast in the equation (2.13), consumption endogenously depends on the stochastic discount factor, which reflects consumption growth. Since an increase in the house price-rent spread makes house prices rise, other things being equal, the amplification effect will make the ratio go down since house prices will increase by more than a change in the spread. This would lead to higher current consumption (and lower savings). Conversely, an increase in the shadow costs of borrowing constraint would make savings more attractive and would lead to a drop in current consumption. Under the no-arbitrage condition, the borrowing constraint would disappear; however, because of the policy intervention, the constraint may be acting, and frictions exist even in equilibrium. This opens up the possibility for current consumption to be driven by beliefs about interest rates and house prices.

An alternative interpretation of the equation (2.13) stems from making use of the rent-to-house-price ratio, (2.9), leading to the expression:

$$\mathcal{S}_t = \mathbb{E}_t \beta \left(\frac{C_{t+1}}{C_t} \right)^{-\nu} Q_{t+1}, \tag{2.14}$$

demonstrating that spread is a forward-looking variable, determined together with consumption and house price growth. The spread is nothing else but an expected house price in the future, discounted by the stochastic discount factor, capturing consumption dynamics. Note that using the house price in (2.12), the spread can be expressed in a more convenient format:

$$\mathcal{S}_t = \left(1 - \mu_t \left(C_t\right)^{\nu} \left(1 - \chi\right)\right) Q_t - R_t^H. \tag{2.15}$$

It makes it clear that the existence of credit frictions would enter the spread variable (when $\mu_t = 0$, the expression collapses to a familiar form: $\mathcal{S}_t = Q_t - R_t^H$).

Lastly, the shadow price of borrowing constraint (2.5) constitutes the last part to make the setting amenable to the empirical analysis:

$$\begin{aligned} C_t &= \left(\left(1-\chi\right)\mu_t\right)^{-\frac{1}{\nu}} \left(\tfrac{Q_t - R_t^H - \mathcal{S}_t}{Q_t}\right)^{\frac{1}{\nu}}, \\ \mathcal{S}_t &= \left(1 - \mu_t \left(C_t\right)^{\nu} \left(1 - \chi\right)\right) Q_t - R_t^H, \\ \mu_t &= \left(C_t\right)^{-\nu} \left(1 - \mathbb{E}_t \beta \left(\tfrac{C_{t+1}}{C_t}\right)^{-\nu} i_{t+1}\right), \end{aligned} \tag{2.16}$$

making it clear that consumption responds to unexpected changes to a borrowing constraint, μ_t, simultaneously determined with the house price-rent spread, $\mathcal{S}_t$. Due to this relationship, we will

[8] For comparison, Berger et al. (2018) find that consumption response to changes in house prices can be approximated by the marginal propensity to consume out of temporary income times the value of housing. Our framework is much simpler and features no heterogeneity, yet provides another way to link house prices and consumption, where borrowing frictions are made to play a key role.

first extract shocks and then run conditional regressions that account for both shocks when tracking how consumption moves to an unexpected change in credit (borrowing) or housing spread (i.e., when learning about the former, we still have to account for the latter and the other way around).

2.6 Elaboration on the Mechanisms

2.6.1 Consumption Smoothing and Housing

Let us elaborate on consumption dynamics further. We can use equation (2.13) to derive the updated Euler equation. For the moment, let us assume that the interest rate is non-stochastic. That assumption would imply that:

$$\mathbb{E}_t \left(C_{t+1}/C_t\right)^{-\nu} = \left(C_{t+1}/C_t\right)^{-\nu} = \frac{1-(1-\chi)^{-1}\left(1-\left(\frac{R_t^H+\mathcal{S}_t}{Q_t}\right)\right)}{\beta i_{t+1}}. \tag{2.17}$$

Hence, an increase in the next period's interest rate would lower the right-hand side of the equation, leading to an increase in consumption in the next period (recall that an increase in consumption growth is raised to a negative power). That implies that households are engaging in precautionary savings by postponing consumption to the next period.

Rearranging (2.17), we obtain

$$\mathbb{E}_t \left(C_{t+1}/C_t\right)^{-\nu} = \tfrac{1}{\beta i_{t+1}} \tfrac{R_t^H+\mathcal{S}_t-Q_t\chi}{(1-\chi)Q_t}.$$

If households could expand their debt by using the full house price, then $\chi \to 0$ and the consumption Euler equation collapses to $\mathbb{E}_t \left(C_{t+1}/C_t\right)^{-\nu} = \tfrac{1}{\beta i_{t+1}} \tfrac{R_t^H+\mathcal{S}_t}{Q_t}$. Absent borrowing constraints, we obtain $\mu_t = 0$, also implying that $\mathbb{E}_t \left(C_{t+1}/C_t\right)^{-\nu} = \tfrac{1}{\beta i_{t+1}}$, since $Q_t = R_t^H + \mathcal{S}_t$. Consumption growth is pinned down by the opportunity costs of consuming in the current period versus next period (intertemporal choice), summarized by the interest rates.

The presence of borrowing frictions, however, leads to the following result:

$$\tfrac{\partial \mathbb{E}_t (C_{t+1}/C_t)^{-\nu}}{\partial \chi} = -\tfrac{1}{\beta i_{t+1} Q_t} \tfrac{\left(Q_t - R_t^H - \mathcal{S}_t\right)}{(1-\chi)^2}.$$

As long as $0 < 1-(1-\chi)\left(1-\mathbb{E}_t\beta\left(C_{t+1}/C_t\right)^{-\nu} i_{t+1}\right) < 1$,[9] we obtain $Q_t - R_t^H - \mathcal{S}_t > 0$ and $\frac{\partial \mathbb{E}_t (C_{t+1}/C_t)^{-\nu}}{\partial \chi} < 0$. That means that the lower debt expansion (higher χ) leads to higher savings (for $\mathbb{E}_t \left(C_{t+1}/C_t\right)^{-\nu}$ to decrease, we require consumption in the current period to decrease, so that it could rise in the next period).

2.6.2 Consumption Smoothing, Housing, and Uncertainty

However, in reality, the process driving the interest rate i_{t+1} is not known at time t, and it entails substantial interest rate (and monetary policy) uncertainty. To derive more transparent implicatoins, we will assume parametric forms. In particular, under joint log-Normality of consumption

[9] This condition is satisfied for the expected consumption growth bounded by $\mathbb{E}_t\beta\left(C_{t+1}/C_t\right)^{-\nu} i_{t+1} < 1$.

and interest rates, we obtain

$$\mathbb{E}_t \left(\frac{C_{t+1}}{C_t} \right)^{-\nu} i_{t+1} = \mathbb{E}_t \exp\left(-\nu \triangle \ln C_{t+1} + \ln i_{t+1}\right),$$

where $\mu_c \equiv \mathbb{E}_t \triangle \ln C_{t+1}, \mu_i \equiv \mathbb{E}_t \ln i_{t+1}$. Following the same logic for the house prices,

$$\mathbb{E}_t \left(\frac{C_{t+1}}{C_t} \right)^{-\nu} \frac{Q_{t+1}}{Q_t} = \mathbb{E}_t \exp\left(-\nu \triangle \ln C_{t+1} + \triangle \ln Q_{t+1}\right),$$

where $\mu_c \equiv \mathbb{E}_t \triangle \ln C_{t+1}, \mu_q \equiv \mathbb{E}_t \triangle \ln Q_{t+1}$. Using properties of the log-normal distribution,[10] taking natural logarithms, we find that (note that Var_t stands for conditional variance):

$$\begin{aligned} \mathbb{E}_t \triangle \ln C_{t+1} = \nu^{-1} \ln \beta - \nu^{-1} \ln \left(\frac{\chi Q_t - R_t^H}{Q_t} \right) \\ +\nu^{-1} \ln \Big[\exp\Big(\mathbb{E}_t \triangle \ln Q_{t+1} + \frac{\nu^2}{2} \text{Var}_t \Big(\triangle \ln C_{t+1} - \frac{1}{\nu} \ln \triangle \ln Q_{t+1} \Big) \Big) \\ - (1-\chi) \exp\Big(\mathbb{E}_t \ln i_{t+1} + \frac{\nu^2}{2} \text{Var}_t \Big(\triangle \ln C_{t+1} - \frac{1}{\nu} \ln i_{t+1} \Big) \Big) \Big]. \end{aligned} \tag{2.18}$$

Therefore, consumption growth, unlike standard applications with precautionary savings, depends on the difference between down-payment and rental rates, $\left|\chi Q_t - R_t^H\right|$, and thus also on the spread, $\mathcal{S}_t$, as well as a nonlinear function, capturing long-term averages of house price growth rates and interest rates, the conditional variability of consumption growth rate, the house prices growth rate and the interest rate. In other words, higher-order terms capturing uncertainty might be additional factors driving consumption dynamics (note that uncertainty about consumption and interest rates is captured by their respective variance terms). These parametric assumptions follow the lines of Hansen and Singleton (1983) (see Appendix A.4.3).

Hence, as portrayed in (2.18), an exogenous change in, say, interest rate uncertainty drives house prices, price-rent spread, and the rental rate to adjust, given all other factors are fixed. For instance, an exogenous rise in the interest rate uncertainty makes the right-hand side rise, too. That is compatible with the spread variable rising, among other configurations. Similarly, a change in borrowing constraint, captured by the down-payment χ, makes not only consumption but also interest rate, its variance, and covariance to adjust. In the extension of the empirical exercise, we will explore whether uncertainty indeed plays a role in determining the impact of credit and house price-rent effects on consumption (see Section 5.2).

3 Empirical Framework

3.1 Data

We start by describing data to test the relationship between the housing spread shock, capturing expectations about future house prices, as noted above, and credit frictions. We use aggregate housing and rental prices to capture changes in household consumption patterns. Table 3.1 summarizes descriptive statistics based on quarterly data for 28 OECD countries, namely: Austria, Belgium, Canada, Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, United

[10] Refer to Appendix A.4.3 for full derivations.

Kingdom, Greece, Hungary, Ireland, Israel, Italy, Japan, Korea Republic, Lithuania, Luxembourg, Netherlands, Norway, New Zealand, Poland, Portugal, Sweden, Turkey, and the United States.

Table 3.1: Descriptive statistics for the panel data (quarterly data)

	Obs	Min - max quarters	Mean	Std. dev.	Min	Max
HH consumption per capita	3587	50 - 202	4153.70	2203.15	809.85	12016.95
Housing index	4986	42 - 242	64.67	40.47	1.83	174.75
Renting index	4791	42 - 203	69.52	30.08	3.68	154.89
HH credit per capita	3519	49 - 201	21531.37	21320.5	208.98	112116.6
Long-term interest rate	4188	50 - 202	5.80	3.81	-.78	25.4
Consumer confidence index	3956	42 - 242	99.98	1.91	84.12	107.96

Total household consumption and household credit variables are in real terms while housing and renting indexes represent their nominal values. For the estimation part, we use the spread between housing and renting indexes. The household consumption variable shows quarterly expenditures, while the credit variable gives cumulative values.

All the variables fall into the time range from Q1 1960 to Q2 2020. The household consumption per capita shows quarterly expenditures and constitutes our main object of interest to capture dynamic consumption smoothing patterns. Housing and rental variables refer to indexes, which are used to map the theory-consistent housing spread shock into its empirical counterpart. Household credit per capita summarizes the level of credit at each quarter, whereas the long-term interest rate refers to the rate at which long-term government paper is issued and the prices of government bonds maturing in ten years.

Venturing into descriptive statistics, the third column of the Table 3.1 gives an idea of the minimum and maximum number of observations for each variable at the country level. Unsurprisingly, the higher number of observations are related to the longer time-series in Western economies such as France, Germany, Canada, United Kingdom, Netherlands, United States, and others, while the lower number are from catching-up countries such as Czech Republic, Greece, Hungary, Lithuania, and Turkey. The consumer confidence index is also included in descriptive statistics and captures consumer sentiments in each quarter. Other statistics on the mean, standard deviation, minimum and maximum values give a better understanding about variables and their distribution. Finally, all the aggregate data are extracted from OECD (Quarterly National Accounts and Main Economic Indicators), IMF (International Financial Statistics), BIS, and some other data sources, with more details outlined in Appendix Table A.3.

3.2 Measuring House Price-Rent Spread

To connect theory with the empirical data, we present examples from the United States, United Kingdom, Spain, and Italy, which serve as a foundation for our housing spread (gap between house price and rent) shock identification framework. As shown in Figure 3.1, we examine historical quarterly fluctuations in housing and rental indexes across all four countries from 1970 to 2020. Notably, the rental index exhibits a consistent upward trend throughout this period without experiencing significant declines. In contrast, the housing index displays more volatile dynamics, with pronounced fluctuations, particularly evident in the early '80s and '90s. The onset of the 21st century introduces even greater volatility, marked by substantial fluctuations in the housing index.

By linking housing and rental prices, we introduce a conventional asset pricing concept. Specifically, we regard the rental index as a variable that represents fundamentals, expected to be the primary driver of housing variation over the long term. This perspective aligns with the theoretical framework outlined in Section 2, which suggests that persistent deviations from house price and rental rates can be attributed to expectations regarding future house prices. Furthermore, these expectations may appear in line with frictions in the credit market. In accordance with the theoretical framework, we define the housing spread shock as the unexplained difference between the house price and its fundamental value. Importantly, both the housing and rental indexes share the same reference year, ensuring that deviations are not influenced by differences in the choice of baseline period.[11]

Figure 3.1: Housing and renting indexes evolution in the United States, United Kingdom, Spain and Italy

With the slight abuse of notation, we map the theory-implied spread (a gap between house price

[11]For robustness purposes, we also conduct an analysis using the growth rates of the gap between house price and rental rates variables. The results of this analysis, as shown in Figure A.1 in the Appendix, align with the findings presented in Section 4.

and rental) variable (see equation (2.10)) into the empirical counterpart in the equation (3.1):

$$\mathcal{S}_{i,t} \equiv \ln(housing\, index)_{i,t} - \ln(rental\, index)_{i,t}. \tag{3.1}$$

We employ logarithmic transformations on the housing and renting indexes and then calculate the difference to obtain the housing spread variable, denoted as $\mathcal{S}_{i,t}$. This definition excludes the amplification effect[12] due to borrowing frictions (refer to the equation (2.15)). However, they are unobservable, so we will be careful in the empirical analysis to always control for credit shocks when inferring the spread shock (and vice versa).

Throughout our analysis, subscripts refer to specific countries indexed by i and time periods indicated by t. This housing spread variable serves as a metric for tracking temporal disparities between house prices and rental rates. In practical terms, if the $\mathcal{S}_{i,t}$ variable exhibits an increase, it means that the housing index is growing at a faster pace than the rental rate within country i. Moreover, the unexplained part of this difference between variables reflects a rising optimism in expectations regarding future house prices. Consequently, households tend to favor homeownership over renting in such circumstances. Conversely, an unexplained decrease in $\mathcal{S}_{i,t}$ implies a preference for renting over purchasing a house.

Figure 3.2 provides an overview of the housing spread variable ($\mathcal{S}_{USA,t}$) dynamics in the United States spanning the past five decades. Additionally, the graph includes the NBER crisis variable, highlighting periods of recession. A noteworthy observation is that during recessionary periods, the appeal of purchasing a house diminishes relative to renting, largely due to financial challenges faced by households. The accumulation of equity based on the appreciation of house prices prior to the crisis, or the confidence generated by rising house prices that led to increased expenditure, ultimately exacerbated households' financial difficulties and reduced their motivation to engage in long-term financial commitments such as buying a house. As previously mentioned, these dynamics were particularly pronounced during the global financial crisis of 2008, which was primarily driven by a substantial decline in house prices and the associated impact on households' perceptions of their housing wealth. Consequently, this effect translated into a prolonged period of weak demand.

3.3 Housing Spread Shock Identification

To evaluate the effects of the housing spread shock and credit frictions on consumption patterns, we start with the description of the empirical strategy. As the theory implies, we deal with the endogenous relationship between consumption and housing choice. To alleviate the endogeneity problem, we identify 'shocks' to the housing spread and credit (and its determinants). Rather than constraining the contemporaneous responses with traditional Cholesky decomposition, we instead identify a shock by imposing longer-horizon restrictions (Ramey (2016)).

To be more precise, we identify shocks for the house price-rent spread and credit by running country-by-country autoregressive distributed lag regressions, controlling for household consumption dynamics, house price-rent spread, and all variables associated with credit frictions. Our

[12] The general spread variable accounts for the amplification effect on house prices: $\mathcal{S}_t = (1 - \mu_t (C_t)^{\nu} (1 - \chi)) Q_t - R_t^H$. Empirically, a shock to the spread variable controls for changes in credit conditions as well as additional factors (see Section 4 for a full description of the identification strategy).

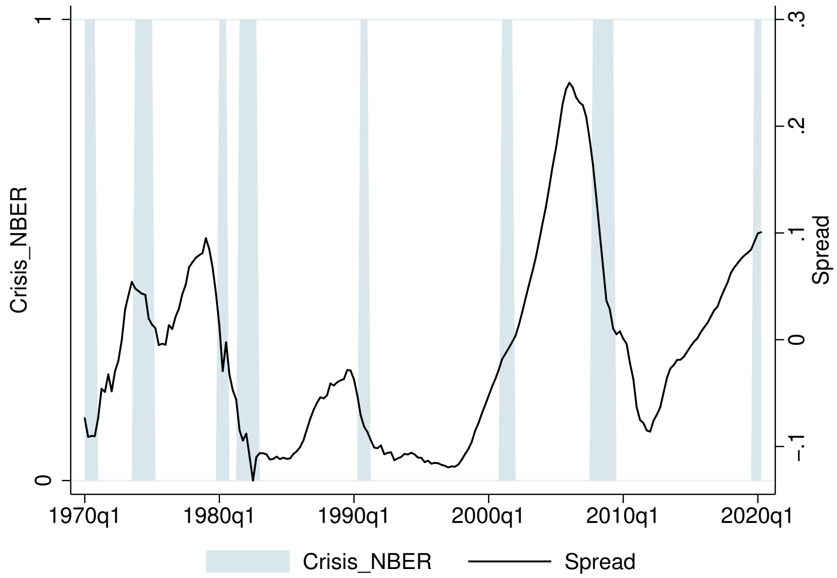


Figure 3.2: House price-rent spread and NBER crisis variables for the United States

identification strategy is similar to the exercise done in the seminal paper by Gertler and Gilchrist (2018) and in line with the estimation method suggested by Shapiro and Watson (1988). We identify shocks as orthogonal residuals to consumption dynamics, housing spread, and credit variables, thereby making them surprise movements in those variables (see Appendix for detailed estimation results).

Our key relationships, summarized by the equations in (2.16), describe how the housing spread, credit (borrowing) frictions, and consumption depend on each other. The empirical counterpart equations (3.2) and (3.3) summarize our empirical identification strategy for the spread and credit (borrowing) variables:

$$\mathcal{S}_{i,t} = \alpha_i + \sum_{h=1}^{4} \rho_{1,i,h}\mathcal{S}_{i,t-h} + \sum_{h=1}^{4} \gamma_{1,i,h}\Delta \ln Cr_{i,t-h} + \sum_{h=1}^{4} \omega_{1,i,h}\Delta \ln C_{i,t-h} + \mu_{i,t}, \tag{3.2}$$

$$\Delta \ln Cr_{i,t} = \beta_i + \sum_{h=1}^{4} \rho_{2,i,h}\mathcal{S}_{i,t-h} + \sum_{h=1}^{4} \gamma_{2,i,h}\Delta \ln Cr_{i,t-h} + \sum_{h=1}^{4} \omega_{2,i,h}\Delta \ln C_{i,t-h} + \varepsilon_{i,t}, \tag{3.3}$$

where $\mathcal{S}_{i,t}$, $Cr_{i,t}$ and $C_{i,t}$ stand for the house price-rent spread, credit and household consumption variables, respectively. We regress house price-rent spread $\mathcal{S}_{i,t}$ during each time period on four lags of itself, on four lags of household credit change $\Delta \ln Cr_{i,t}$, and four lags of the change in quarterly household consumption $\Delta \ln C_{i,t}$ (equation (3.2)). We also repeat the same procedure using the household credit change instead of the house price-rent spread on the left side of the equation (3.3). As already mentioned, the most important piece of information comes from the residuals matrix as we interpret them as shocks to the house price-rent spread and credit change, which cannot be explained by the lags of house price-rent spread, credit change, or consumption dynamics. The residuals in these regressions should also be interpreted as 'innovations' in analyzed variables that are orthogonal to fluctuations in consumption and to each other.

Drawing from the insights in Section 2, shocks to the housing spread should encapsulate households' expectations about future housing wealth (prices), stemming from factors akin to 'animal spirits,' which are not reflected in the fundamentals. Given that borrowing frictions can exacerbate this effect, we must also account for credit dynamics. Our empirical approach is best understood by considering the consumption equation (2.13) and the shadow price of the borrowing constraint (2.5). There are three underlying sources of dynamics driven by changes in consumption, interest rates, and house prices, which are encapsulated by the spread variable, encompassing both house prices and rental rates. After controlling for co-movements, we isolate orthogonal residual terms, which are interpreted as shocks to the housing spread and credit.

Furthermore, it is important to acknowledge the inherent volatility and noise in the $\ln Cr_{i,t}$ variable. To mitigate this, we opt for a moving average approach that considers the preceding four periods, along with the current level of the variable, to estimate changes in credit.[13] Finally, in exploring potential connections between the housing spread and credit shocks, we employ the panel Granger causality test introduced by Juodis et al. (2021). The results presented in Appendix Table A.2 indicate that the credit shock does not exert a causal influence on the house price-rent spread. Conversely, the reverse causal relationship holds true. Our principal variable, capturing households' expectations, demonstrates predictive power concerning the credit shock, affirming its significant role in driving aggregate fluctuations.

3.4 What Do Identified Shocks Capture?

To further motivate the importance of the housing spread shock and provide additional intuition, we present plots of the housing spread and credit shocks for major countries. In Figure 3.3, we display 4-period (1-year) moving averages of housing spread and credit shocks for the United States. We employ a moving averages approach to smooth the shocks, making them visually easier to inspect. Additionally, we overlay the consumer sentiment index and recession periods onto the graph to highlight common dynamics and facilitate the interpretation of our shocks.

From Figure 3.3, we observe that over the last 50 years, the United States has experienced four recessions. While these recessions may differ with respect to causes, three of them exhibit significant drops in both the consumer sentiment index and the housing spread shock variable. This observation suggests a connection between consumer sentiments and the housing spread shock, as households may be concerned about the value of their housing assets or their ability to purchase homes in the future. In contrast, the credit shock does not display a similar pattern of co-movement with consumer sentiment, especially during recessionary periods. This evidence supports the notion that our housing spread shock captures genuine variation in household expectations that contributes to explaining consumption fluctuations. Additionally, we examine the correlations between the time series of shocks and find consistent results, with no significant correlation between the credit shock and consumer sentiments.

[13] Our qualitative findings remain unaffected when employing the original shock series; however, for visualization purposes, we employ the adjusted series as our baseline.

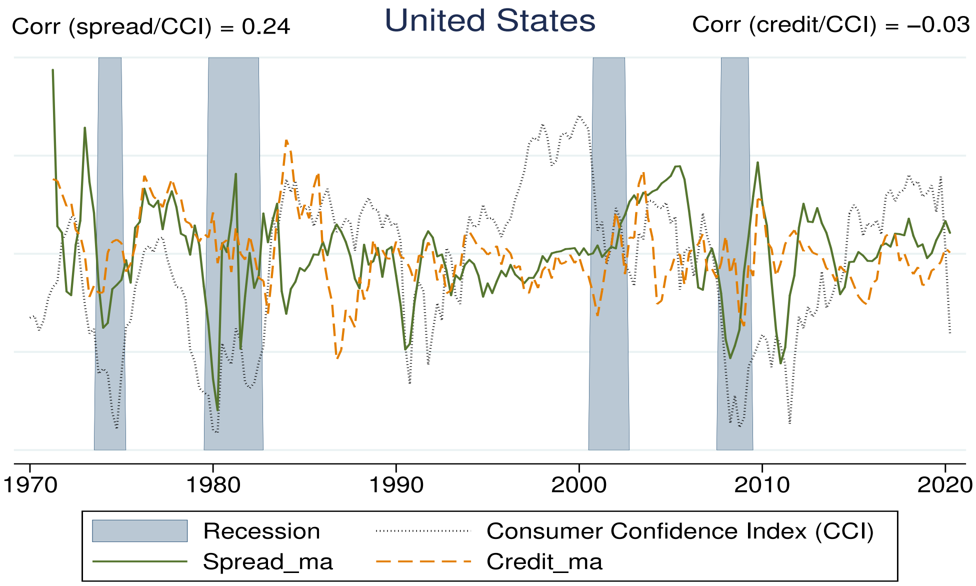


Figure 3.3: Recession, Consumer Sentiment Index, Housing Spread Shock, and Credit Shock smoothed (by moving average) variables for U.S.

However, a different pattern emerges for the housing spread shock, which exhibits a modest yet statistically significant correlation with the consumer sentiment index, considering the number of observations used. We replicate these analyses for other major economies, including Canada (Figure A.13), Germany (Figure A.14), France (Figure A.15), the United Kingdom (Figure A.16), Italy (Figure A.17), and Japan (Figure A.18), and find similar results. While the correlation between the credit shock and consumer sentiments appears somewhat stronger for some countries than for others, it generally remains weak. Conversely, the housing spread shock (household expectations about house prices) consistently exhibits a significant correlation with the consumer sentiment index for most of the analyzed economies. In summary, the housing spread shock often co-moves significantly with the consumer sentiment index, suggesting shared components, especially during recessions.

When examining our shocks, we observe variations in the correlation between the housing spread shock and the consumer sentiment index across different countries. To shed light on potential explanations for these differences, we turn our attention to the institutional setup within each country. As one alternative approach, we investigate the proportions of wealthy hand-to-mouth (HtM) households in each country, a concept inspired by Kaplan et al. (2014). This perspective is intriguing because wealthy HtM households play a pivotal role in our analysis. Wealthy HtM households typically possess substantial illiquid assets, such as housing, while facing constraints on their consumption. However, an increase in house prices enhances household wealth, enabling wealthy HtM households to utilize this newfound wealth to borrow and spend. Consequently, we anticipate that the correlation between the housing spread shock and the consumer sentiment index would be stronger in countries with a higher proportion of wealthy HtM households. Figure 3.4 illustrates this relationship by plotting countries based on their shares of wealthy HtM households and the correlations between housing spread and credit shocks. Our findings from Figure 3.4 corroborate this expectation, revealing that the correlations between the housing spread shock (household expectations about house prices) and the consumer sentiment index are notably higher in countries with larger shares of wealthy HtM households. For instance, significantly higher correlations are evident in the United Kingdom and Germany, where the proportion of wealthy HtM households is relatively larger than in Spain or Italy.

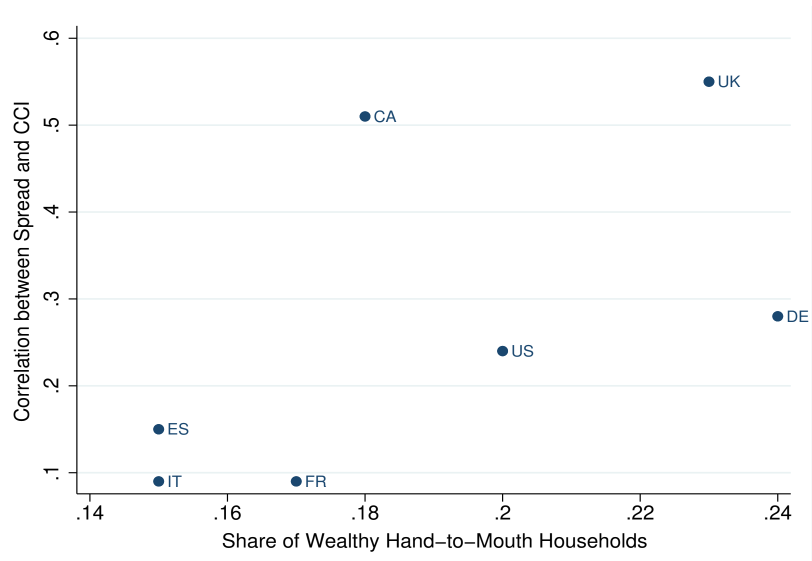


Figure 3.4: Shares of Wealthy Hand-to-Mouth households (Kaplan et al., 2014) and correlations between housing spread shock and consumer sentiment by countries. Correlations are estimated for period between 1995 and 2020 to keep consistent results between countries.

3.5 Shocks in the Regression Setup

After having identified shocks, we use them as explanatory variables in the fixed-effects panel local projections regressions (Jordà, 2005), thereby capturing responses of consumption changes to the housing spread (household expectations) and credit shocks. In order to stay in line with our theory, we start with a simple model in which the response variable is the quarterly household consumption expenditure changes observed for the 12 quarters and projected on the shocks and control variables, allowing for the horizon-specific parameters on all of them. More precisely, if we used a housing spread shock, then we control for the credit shock, and vice versa. For instance, if the housing spread shock (household expectations) is our main interest, then we regress changes in household spending over the main shock (housing spread shock), also controlling for the change in credit shock and its lags. As the equations (3.4) and (3.5) show below, we run this procedure twice to capture separate household consumption responses over the housing spread and credit shocks:

$$\Delta \ln C_{i,t} = \beta_i + \sum_{h=0}^{1} \rho_{3,i,h} \mu_{i,t-h} + \sum_{h=0}^{1} \gamma_{3,i,h} \Delta \ln \varepsilon_{i,t-h} + \epsilon_{1,i,t}, \tag{3.4}$$

$$\Delta \ln C_{i,t} = \beta_i + \sum_{h=0}^{1} \rho_{4,i,h}\varepsilon_{i,t-h} + \sum_{h=0}^{1} \gamma_{4,i,h}\Delta \ln \mu_{i,t-h} + \epsilon_{2,i,t}, \tag{3.5}$$

where $C_{i,t}$, $\mu_{i,t}$ and $\varepsilon_{i,t}$ stand for the household consumption, housing spread shock and credit shock variables, respectively.

It is of interest to compare the dynamics of the housing spread shock with its level. In the Appendix, we provide an account of how the identified housing spread shock behaves concerning the NBER crisis variable (refer to Figure A.1). We observe prolonged periods characterized by persistently positive shocks, marked by substantial volatility until the early 1990s and during the global financial crisis. These crisis periods are consistently linked to highly volatile episodes of the housing spread shock. Considering the persistence of the housing spread shock (as seen in Figure 3.2), we also investigate the potential non-stationarity of both the housing spread and credit shock variables. As detailed in Appendix Table A.1, the null hypothesis of a unit root in a panel setting is resoundingly rejected, providing empirical support for the subsequent analysis. We also conduct an extensive analysis on how our housing spread shock differs from what the literature has extensively used – a change in house prices – covering economic and statistical aspects in Appendix Section A.2.

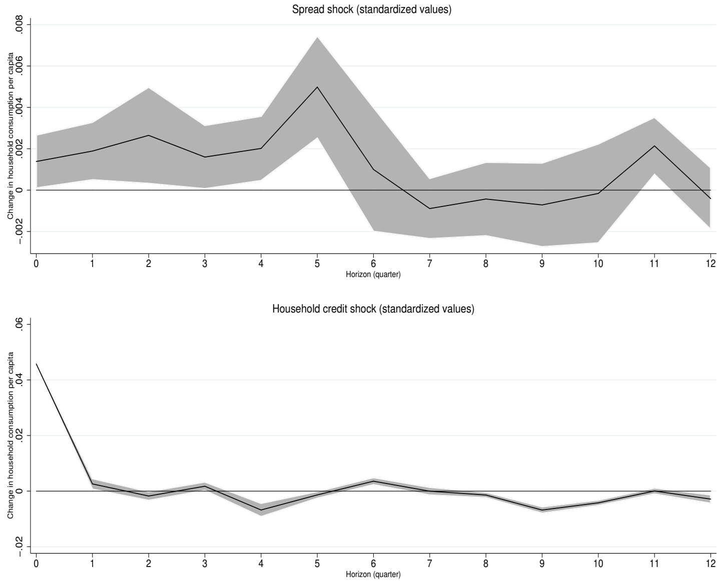
4 Empirical Results

4.1 Baseline Model

We set out by summarizing the main empirical results. Our object of interest is the theory-driven consumption equation (2.13), which decomposes consumption changes into household expectations regarding house prices (housing spread shock) and credit (borrowing) frictions. Since they are endogenously pinned down, we are dealing with orthogonalized shocks, described in Section 3 and depicted in Figure 4.1. It is of interest to explore whether there is sufficient explanatory power from each source after conditioning on the other. The upper graph demonstrates that an unexpected increase in household expectations concerning house prices, conditioned on the credit shock, significantly positively affects consumption, thereby making households more willing to consume and save less, reaching a peak in the fifth quarter, and almost entirely dissipating after six quarters. This effect comes from the fixed effects panel local projection with clustered standard errors at the country level (the shadowed area depicts 95% significance bounds).

The bottom graph of Figure 4.1 shows households' consumption responses to the credit shock. Compared to the household expectations about house prices, the main difference is that credit affects consumption instantaneously and the effect stays only for a quarter. It is clear that the two sources of consumption drivers are very different qualitatively: household expectations regarding house prices are more persistent and last longer, whereas changes in credit are significant, as shown in extensive literature (Aron et al., 2012; Mian et al., 2013; Mian and Sufi, 2018), but very short-lived.

Having seen that the housing spread shock displays a more persistent effect on consumption than the usual suspect, credit frictions, one may wonder what alternative interpretation one could attach to it. Since we control for rental rates (fundamentals) in constructing the housing spread variable,



Note: Fixed effects panel regression with horizon-specific intercepts is used to estimate local projections. Standard errors are clustered by countries.

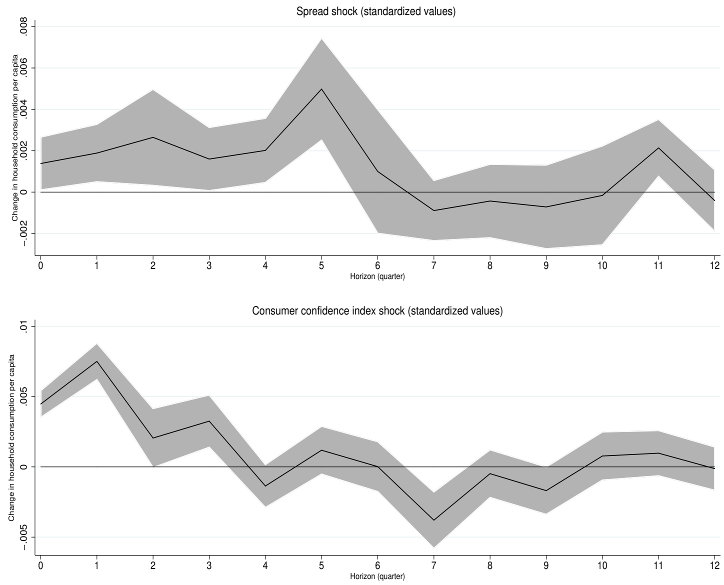
Figure 4.1: Impulse responses for the household consumption spending

the orthogonal shocks collected in our empirical framework can be seen as household expectations about the future worthiness of housing assets. In other words, both the theory (see Propositions 1 and 2, and Corollary 4) as well as the shock identification strategy, allow us to interpret the housing spread shock as the possibly persistent component, driven by household expectations and leading to the formation of housing bubbles. To test this idea, we collect the consumer confidence index – a standard indicator for consumer expectations – and estimate shocks, using the same identification strategy, given in equations (3.2) and (3.3). The only difference is that we are now using changes in the consumer confidence index instead of the house price-rent spread. We collect and visualize consumer confidence index-related results in Figure 4.2.

To ease the comparison, the upper graph of Figure 4.2 replicates the same housing spread shock (household expectations) effect on consumption as in Figure 4.1, whereas the lower graph depicts the impact of the consumer confidence index shock. Unlike the housing spread shock, a consumer expectations shock moves households' consumption earlier but, unlike the credit shock, the effect is more persistent and exerts a positive impact for at least three quarters. The magnitude of the effect due to the consumer confidence shock is smaller than that of the housing spread shock, but standard deviations also differ between these variables,[14] thereby somewhat complicating the comparison of effects. Nonetheless, the two variables cause a qualitatively comparable response in household consumption spending.

After showing similarities between consumer sentiments and housing spread shocks, it becomes easier to interpret the local projection results given in Figure 4.1. Consumer sentiments usually

[14] Descriptive statistics in Table 3.1 shows 40.82 as the standard deviation for the housing index and 1.81 for the consumer confidence index.



Note: Fixed effects panel regression with horizon-specific intercepts is used to estimate local projections. Standard errors are clustered by countries. Consumer confidence index is used as the alternative and comparison to the housing spread shock variable. Norway is missing in this estimation due to the lack of data on consumer sentiments.

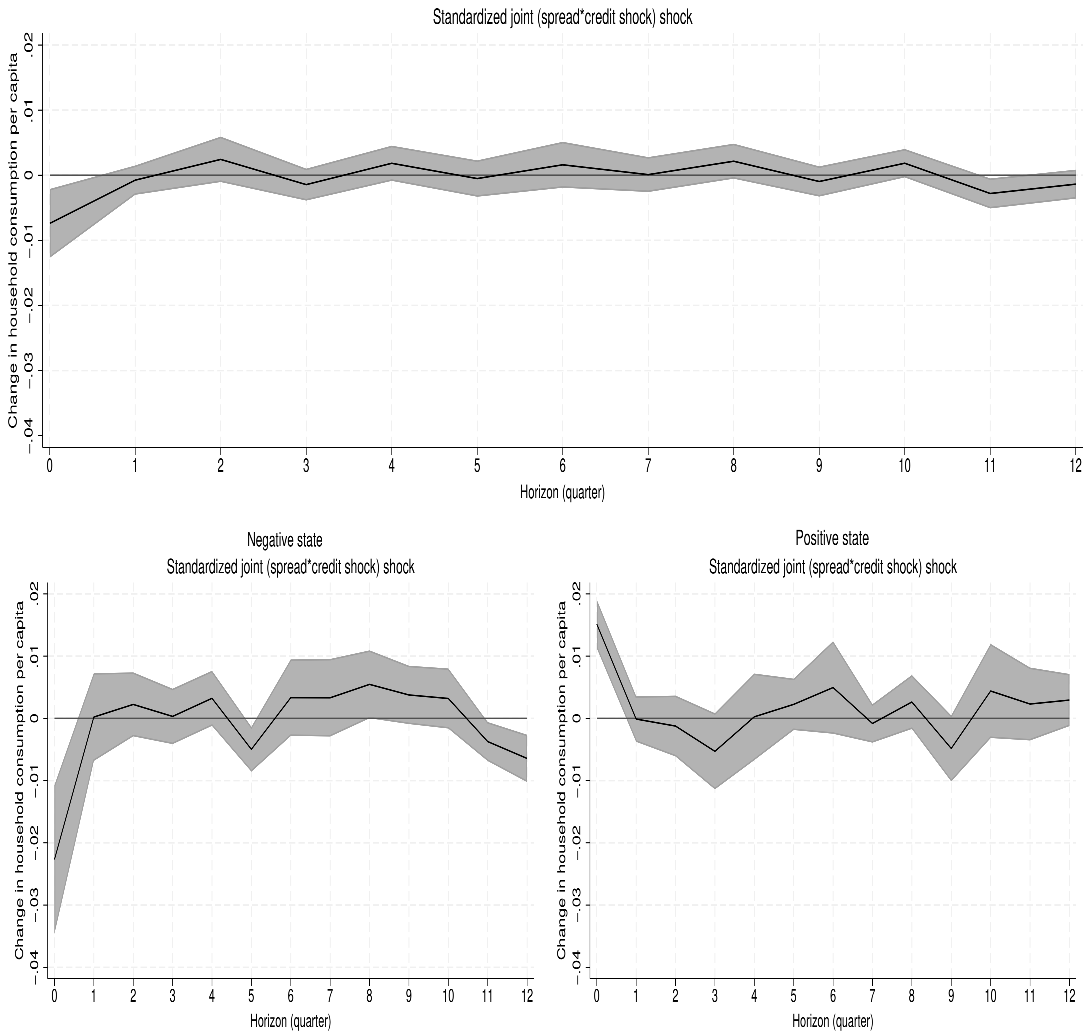
Figure 4.2: Impulse responses for the household consumption spending (consumer confidence index shock instead of the house price-rent spread shock)

behave as a variable that grows persistently and the same is expected from household expectations regarding house price. It takes 4-5 periods to build household expectations that affect household consumption. To put this in context with real data, the gap between house prices and rental rates was growing for some time and it started moving in the opposite direction just before the financial crisis (see Figure 3.2), indicating a potential downturn in household consumption. Moreover, as consumer sentiments do not switch immediately, they took 4-5 quarters to adjust in this case.

It is also important to mention that the consumer confidence index captures expectations that can be driven by many different factors – income, wealth, general economic conditions, and others. In contrast, the house price-rent spread shock captures household expectations that are closely driven by their housing wealth, yet are orthogonal to credit and consumption changes. Though the spread variable is an indirect measure of expectations, it is cleaner than other alternatives due to orthogonalization and, unlike sentiment or confidence indexes, is easy to construct for a larger number of economies.

4.2 Joint Effect and State Dependence

To identify joint and state-dependent effects, we divide consumption reactions into periods of growth and decline. To achieve this, we establish criteria for defining 'positive' and 'negative' states. A 'positive state' is identified if two conditions are met. First, household credit should increase (credit growth should be higher than zero). Second, house price growth should surpass the rental rates in the same quarter. In essence, house prices should grow at a faster rate than rental rates, moving away from the rental rate's trend. Conversely, 'negative states' are identified when the opposite of these two conditions holds true. Household credit should decrease, and the change in rental rates should exceed the growth in house prices. Having established these states, we can then examine whether household expectations, credit, and their joint effect (housing spread shock * credit shock) yield different reactions across these states.



Note: Fixed effects panel regression with horizon-specific intercepts is used to estimate local projections. Standard errors are clustered by countries. Interaction variable is given as a product of standardized housing spread and credit shocks. First column shows local projections identified for the period when the housing index grows more slowly than the rental rate index. Alternatively, second column displays results over the positive time periods when the housing index grows faster than the rental rate index.

Figure 4.3: Household consumption responses by states (with standardized shocks)

Figure 4.3 visualizes the results. The top graph shows the outcome over all time periods, the left column summarizes effects over the 'negative state,' while the right column depicts results for the 'positive state.' Since the housing spread and credit shocks can have different scales in their values, simple interaction between variables will be hard to interpret in terms of magnitudes. We therefore standardize housing spread and credit shocks to have a mean of zero and the standard deviation of 1. In this case, an interaction variable will also be standardized and comparable with the individual shock results.[15].

Hence, when shocks happen simultaneously, controlling for individual (housing spread and credit) shock results, we find no additional amplification effect that the joint shock variable brings when looking at the top graph, which visualizes the joint effect over all time periods. However, we find evidence for asymmetric effects over different states of the economy, as presented in the bottom graphs of Figure 4.3. The graph on the left summarizes the results for the negative state. When household credit growth is negative and rental prices grow more than house prices, an immediate drop in consumption due to both shocks acting together is documented in the first quarter. Additionally, a smaller drop is also captured in the fifth quarter.

In the positive state of the economy, the joint effect also materializes and brings the opposite dynamics. This means that positive expectations about house price growth and growing household credit increase consumption in the first periods. However, it is important to highlight that the magnitudes of joint effects happening in 'positive' or 'negative' states are different and generate asymmetries across the states. Moreover, we empirically demonstrate asymmetry in reactions to positive and negative shocks. Finally, we show that household expectations and credit frictions simultaneously explain an important part of the consumption dynamics.

5 Extensions and Discussion

5.1 Determinants of Borrowing Frictions

As we discussed briefly in Section 2, the drivers of borrowing frictions can include interest rates, driven by domestic as well foreign financial markets and monetary policies. It all depends on the development of the local financial markets and the importance of the global component (U.S. monetary policy) on the local financial conditions (e.g., Miranda-Agrippino and Rey, 2020).

To see the role of home and foreign interest rate shocks, we will explore long-term rates. To analyze the interest rate channel, we employ the same procedure we used in (3.2) and (3.3), and identify housing spread and credit shocks. As an additional control, we include four lags of changes in domestic long-term interest rate ($i_{i,t}$) and re-estimate housing spread (5.1) and credit (5.2) shocks. Moreover, we identify a domestic interest rate (monetary policy) shock by regressing its change on four lags of itself, on four lags of household credit change, four lags of house price-rent spread, and four lags of the change in quarterly household consumption (5.3). Finally, we repeat the same procedure twice to account for the domestic and US interest rate shocks separately.

$$\mathcal{S}_{i,t} = \alpha_i + \sum_{h=1}^{4} \rho_{1,i,h} \mathcal{S}_{i,t-h} + \sum_{h=1}^{4} \gamma_{1,i,h} \Delta \ln Cr_{i,t-h} + \sum_{h=1}^{4} \omega_{1,i,h} \Delta \ln C_{i,t-h} + \sum_{h=1}^{4} \eta_{1,i,h} \Delta i_{i,t-h} + \mu_{i,t}, \quad (5.1)$$

[15] Results of replicated Figure 4.1 without standardized housing spread and credit shocks, and without credit shock modelled in moving averages are given in Appendix Figure A.2 and Figure A.3. They show much the same dynamics as in Figure 4.1

$$\Delta \ln Cr_{i,t-h} = \beta_i + \sum_{h=1}^{4} \rho_{2,i,h} \mathcal{S}_{i,t-h} + \sum_{h=1}^{4} \gamma_{2,i,h} \Delta \ln Cr_{i,t-h} + \sum_{h=1}^{4} \omega_{2,i,h} \Delta \ln C_{i,t-h} + \sum_{h=1}^{4} \eta_{2,i,h} \Delta i_{i,t-h} + \varepsilon_{i,t}, \tag{5.2}$$

$$\Delta i_{i,t-h} = \nu_i + \sum_{h=1}^{4} \rho_{3,i,h} \mathcal{S}_{i,t-h} + \sum_{h=1}^{4} \gamma_{3,i,h} \Delta \ln Cr_{i,t-h} + \sum_{h=1}^{4} \omega_{3,i,h} \Delta \ln C_{i,t-h} + \sum_{h=1}^{4} \eta_{3,i,h} \Delta i_{i,t-h} + \epsilon_{i,t}. \tag{5.3}$$

We analyze household consumption dynamics by including the domestic and US long-term interest rate shocks separately. The findings are documented in Appendix Figure A.20. One may argue that the short-rates better capture borrowing conditions for the households who use the banking sector to take mortgages and extend shorter-term credit. Long-term rates, on the other hand, include a market-based forward-looking component, which is an important determinant for a long-term financial commitment such as a mortgage.

We find that consumption responds similarly to the housing spread and credit shock and supports the baseline results even after including changes in the interest rates. In addition, domestic and US long-term interest rates shocks deliver highly similar outcomes, at least indirectly confirming the prominent role of US monetary policy for international consumption dynamics. Viewed through the lenses of the domestic and US long-term rate's impact, the 'boom-bust' dynamics are preserved for both cases (see Appendix Figure A.20).

As is clear from the bottom graphs in Figure A.20, consumption responds quickly, and the effect is not as short-lived as was the case for the household credit shock. More precisely, the interest rate shock delivers a positive impact in the first three quarters, though it turns into a strong negative effect in the sixth quarter, resembling changes in the relative price of inter-temporal consumption smoothing. The same dynamics hold for both cases – either analyzing a domestic or US long-term interest rate shocks. In addition to the Euler-equation-driven explanation, changes in credit conditions amplify the effects of household expectations about the future value of house price. Similarly, Mian et al. (2017); Mian and Sufi (2018); Kaplan et al. (2020) explain the 'boom-bust' episodes over consumption by the credit market liberalization, credit expansion, larger debt, and sudden stops, leading to severe contractions. In other words, credit market liberalization and monetary policy changes, in terms of interest rates, stimulate household credit expansion, followed by an increase in household spending, which eventually reverses after some periods and creates a 'boom-bust' situation in the aggregate demand.

5.2 The Role of Uncertainty

Having shown that the household expectations is a useful measure to capture changes in consumption dynamics as well as the asymmetric effects that particularly happen during different states, we extend the baseline model to account for uncertainty. We base our empirical investigation on the theory extension, covered in Section 2.6.1 and summarized in the equation (2.18).

Instead of assuming exogenous processes for interest rates and house prices, we impose parametric restrictions on consumption and interest rates as well as consumption and house prices. Following Hansen and Singleton (1983), we assume conditional Normality which allows us to derive closed-form expressions that additionally feature measures of uncertainty. In other words, consumption growth, unlike standard applications with precautionary savings, depends on the difference between down-payment and rental rates, $\left|\chi Q_{i,t} - R^H_{i,t}\right|$, and thus also on the spread, $\mathcal{S}_{i,t}$, as well as a nonlinear function capturing long-term averages of house price growth rates and interest rates, the conditional variability of consumption growth rate, the house prices growth rate, and the interest rate. The latter ingredients capture uncertainty regarding all forward-looking variables. See Appendix A.4.3 for technical details.

When conducting the empirical analysis, we extend the baseline specification and include three new variables, namely macroeconomic uncertainty, monetary policy uncertainty, and housing uncertainty, proxying theoretical counterparts, i.e. variances of consumption, interest rates, and house prices.[16] Figure 5.1 replicates analysis of the joint shock across states, as was done in Figure 4.3.

The claim in Lemma 2.1 remains confirmed. We also find additional evidence that the negative state leads to stronger changes in consumption. It appears that once we control for uncertainty, the negative state (bottom left graph) exhibits a larger joint effect than before. Qualitatively, the impact of the joint effect remain similar and statistically significant in the positive state even after controlling for additional uncertainty measures.

5.3 The Role of Heterogeneity

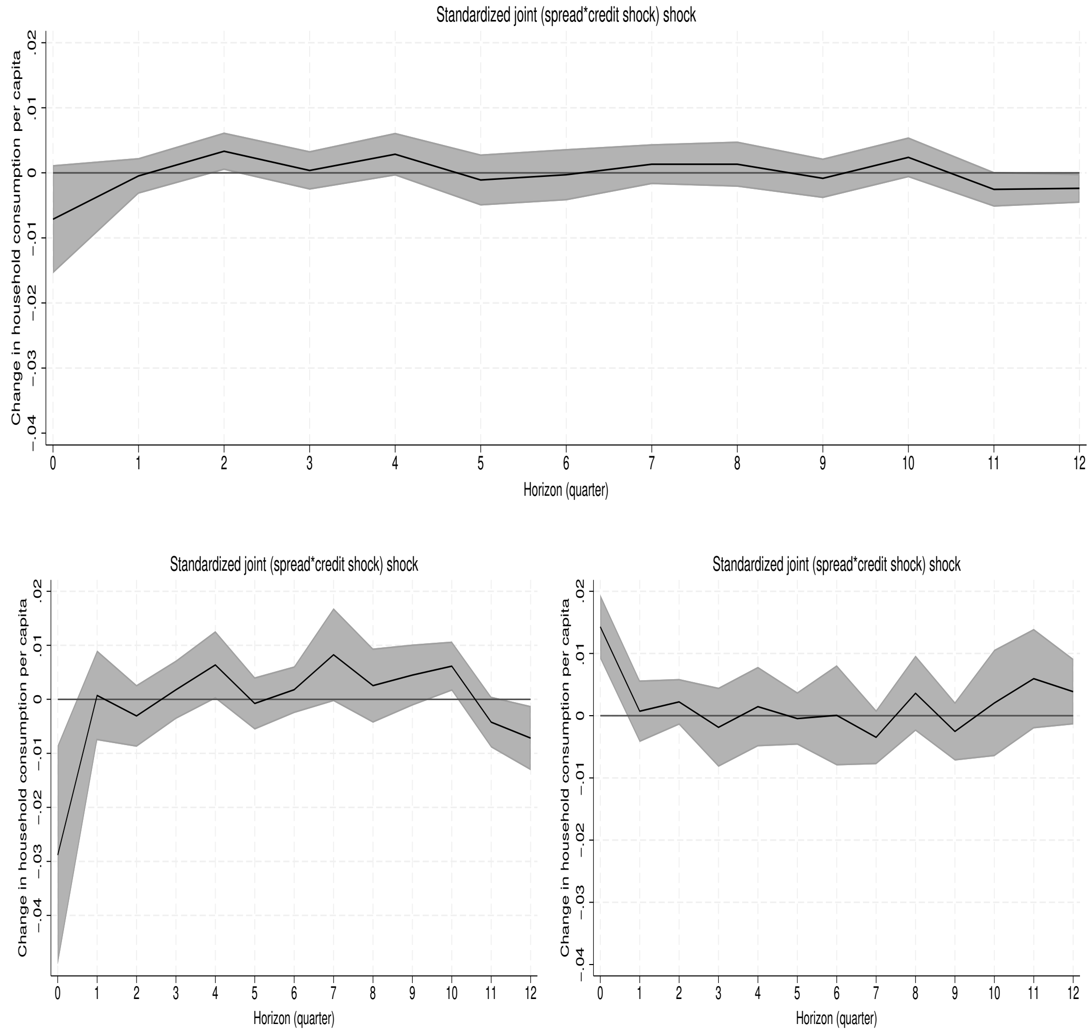
Further, we examine how the heterogeneity among countries may impact the results. To explore this, we categorize the countries into subgroups: advanced economies and catching-up economies. Additionally, and consistently with our focus on household consumption, we classify countries based on their levels of household consumption per capita. This approach allows us to analyze whether the economic dynamics observed in our baseline results vary across different levels of economic development and household consumption.

The findings, presented in the Appendix Figure A.24, reveal that the overall dynamics of the baseline results remain consistent across the different subgroups. This qualitative consistency suggests that the initial conclusions of our analysis are robust across varying economic contexts. Nonetheless, we observe some differences in the persistence and magnitude of effects between advanced and catching-up economies.

For advanced economies, the dynamics and effects of housing spread and credit shocks exhibit greater persistence over time. This stability could be attributed to well-developed institutions and better policy frameworks in these economies, which enhance their ability to absorb and mitigate economic shocks effectively. In contrast, catching-up economies display stronger ("spikier") and more immediate reactions in both directions in response to shocks.

These differences can arise due to the relative underdevelopment of institutions in catching-up economies, which may lead to more pronounced fluctuations in response to external shocks. Additionally, the lower economic resilience and adaptability level in these economies could contribute to

[16] Table A.3 describes the variables and their sources.



Note: Fixed effects panel regression with horizon-specific intercepts is used to estimate local projections. Standard errors are clustered by countries. Interaction variable is given as a product of spread and credit shocks. First column shows local projections identified for the period when the housing index grows slower than the rental rate index. Alternatively, second column displays results over the positive time periods when the housing index grows faster than the rental rate index. Local projections are controlled for macroeconomic Jurado et al. (2015), monetary policy Baker et al. (2016) and housing Mack et al. (2011) uncertainty measures.

Figure 5.1: Household consumption responses by states (controlled for different uncertainty measures)

the heightened sensitivity observed. From a practical perspective, our findings are qualitatively confirmed across different country groups, but the magnitude and persistence of effects vary depending on economic heterogeneity.

6 Robustness Checks

To evaluate the robustness of our baseline results, we investigate various dimensions. Firstly, we assess the stability of local projections while considering the influence of past consumption. To explore this, we include an additional four lags of change in consumption when calculating local projections. The results are presented in Appendix Figure A.4, demonstrating the consistency of our findings across different lag structures.

We also account for unobserved heterogeneity by including time fixed effects as additional controls in our baseline local projections. The summarized results are presented in Appendix Figure A.5, which further confirms the robustness of our baseline results. Importantly, the incorporation of additional time fixed effects does not substantially change the initial dynamics or the response of household consumption to household expectation and credit shocks.

Furthermore, we investigate the possibility of non-linearity by introducing an interaction variable, which is the joint product of house price-rent spread variable and credit changes, into our shock identifying equations 3.2 and 3.3. The results, as depicted in Appendix Figure A.6, offer further confirmation of the stability of our initial baseline findings. Importantly, the inclusion of this interaction variable does not significantly diverge from our original baseline results.

In addition, we also examine a possible endogeneity that could be considered among the variables of our estimation procedure. To support this, we perform additional robustness checks by including the US stock market, as a proxy for financial market expectations, and the principal component (as a proxy for the global component) between the changes in the consumption, credit and house price-rent spread variables in the baseline local projections. The results in Appendix Figure A.22 include controls for changes in the US stock market and support the baseline results by producing a very similar dynamic. Another set of results is shown in Appendix Figure A.23 and controls for changes in the principal component between consumption, credit and household expectations. Hence, the baseline results hold, while the response of household consumption to the credit shock is found to be more persistent and negative, lasting between 1 and 6 quarters.

7 Conclusions

We build on the recent demand side and household balance sheets literature, which suggests housing as the essential factor in explaining household spending fluctuations. We developed a stylized model with the household sector, borrowing frictions, and the role of expectations regarding houses' future worthiness. Instead of merely looking at house prices or credit dynamics, we derive a theory-consistent housing spread shock variable, defined as an unexplained deviation between house prices and fundamentals (rental rates). The spread is allowed to vary over time and react to changes in house prices, rental rates, and credit conditions. The housing spread variable is forward-looking and resembles a measure of expectations about the future housing market.

However, unlike traditional sentiments' measures, which come in various forms, time frames and are rooted in different methodologies, this model enables us to explore household consumption dynamics in 28 OECD economies over the last 50 years. The housing spread shock causes a very similar response in household consumption spending to the consumer confidence index, reflecting similar phenomena behind both. Compared to the credit shock, the housing spread shock is a qualitatively different source of cyclical fluctuations and delivers considerably more persistent effects on household consumption, whereas the credit shock produces an immediate strong effect and the following 'boom-bust' episodes, as found in the earlier literature.

Another important finding comes from the joint effect of borrowing frictions and household expectations. We find a substantial and asymmetric joint effect when both shocks (housing spread and credit) occur simultaneously, particularly in extreme situations like a 'negative state' when credit contracts and house price growth is slower than that of rent. This result highlights the significance of policy recommendations. When standard tools, such as monetary policy, are less effective, perhaps due to the effective lower bound, addressing credit conditions should be accompanied by policies that target expectations about the future state of the economy. We underscore how the two are interlinked and cannot be analyzed or tracked separately. We observe detrimental effects of binding borrowing frictions and poor future expectations, as well as evidence of asymmetric effects for both shocks happening at once, again emphasizing the importance of monitoring and utilizing both measures to stabilize the real economy.[17]

We leave many important questions for future research. Our emphasis has been on the household sector, but the production side seems as important too. Changes in credit conditions and household expectations affect consumption and labor supply; both are of crucial importance for employers and their decisions. Another reinforcing mechanism can come from income (unemployment) risk and at least partly explain households' expectations effect. Adding an additional layer of firm expectations on future demand conditions and prices would also help draw more robust policy implications, enhancing our understanding of interactions between credit frictions, agents' expectations, and their joint impacts on real activity.

[17] Recently, Gilbukh et al. (2023) proposed integrating the price-to-rent ratio into macroprudential policy to establish countercyclical loan-to-value ratios. While we support this policy direction, our research reveals more complex dynamics in the interplay between housing spread and credit. These factors tend to amplify each other during downturns, suggesting the need for future research to disentangle their individual effects for more robust policymaking.

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A Online Appendix

A.1 Empirics

A.1.1 The Housing Spread Shock

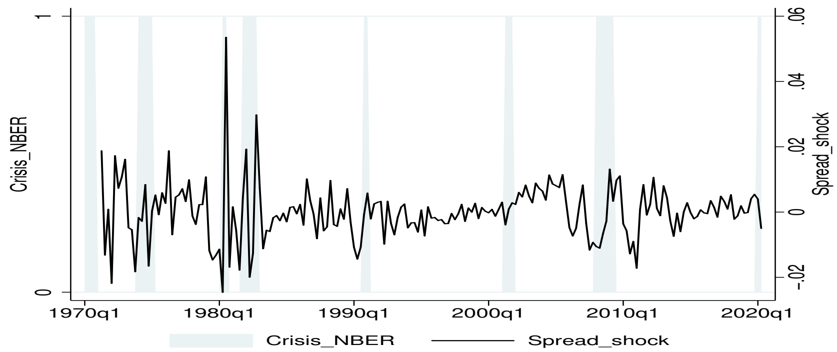


Figure A.1: Housing spread shock and NBER crisis variables for the United States

Table A.1: Panel unit root tests

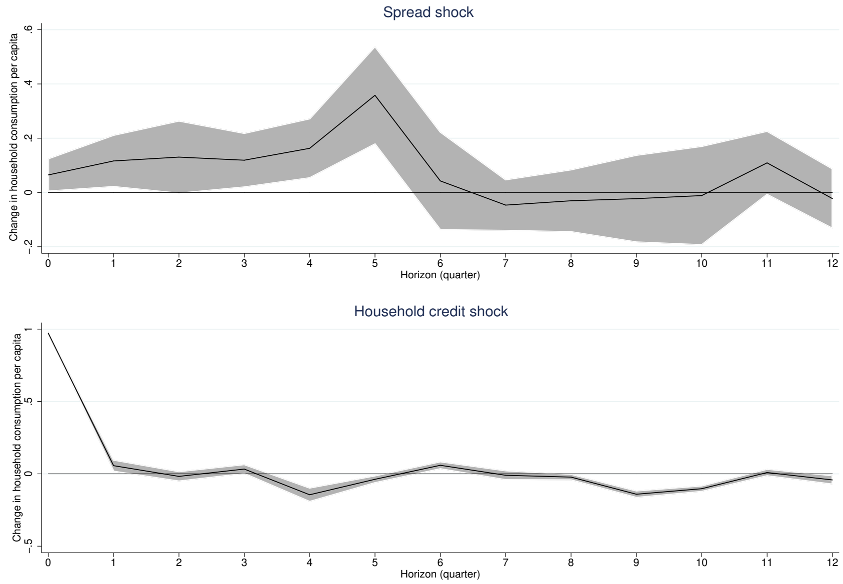
		IPS no trend	IPS with trend	Fisher-type no trend	Fisher-type with trend
e_spread	Z-score	-34.7375	-34.8956	-39.6446	-37.9712
	p-value	0.000	0.000	0.000	0.000
e_credit	Z-score	-34.8708	-34.9690	-39.7470	-38.0947
	p-value	0.000	0.000	0.000	0.000
	Number of panels	28	28	28	28
	Av. number of periods	101.46	101.46	101.46	101.46

The first and second columns identify results for Im-Pesaran-Shin tests with and without time trend. The third and fourth columns summarize results from Fisher-type tests with and without time trends, respectively.

Table A.2: Panel Granger-cause test

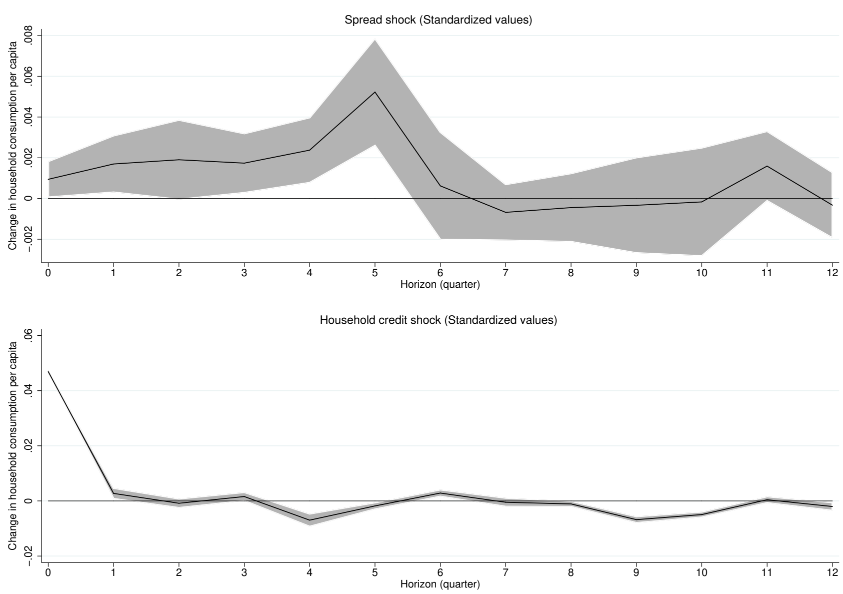
	Credit shock causes housing spread shock	Housing spread shock causes credit shock
HPJ Wald test	0.9318	10.6719
p-value	0.9200	0.0305

H0 claims that the first variable does not Granger-cause the second one. H1 claims that the first variable does Granger-cause the second one for at least one country. 4 lags are used for the Granger-cause.



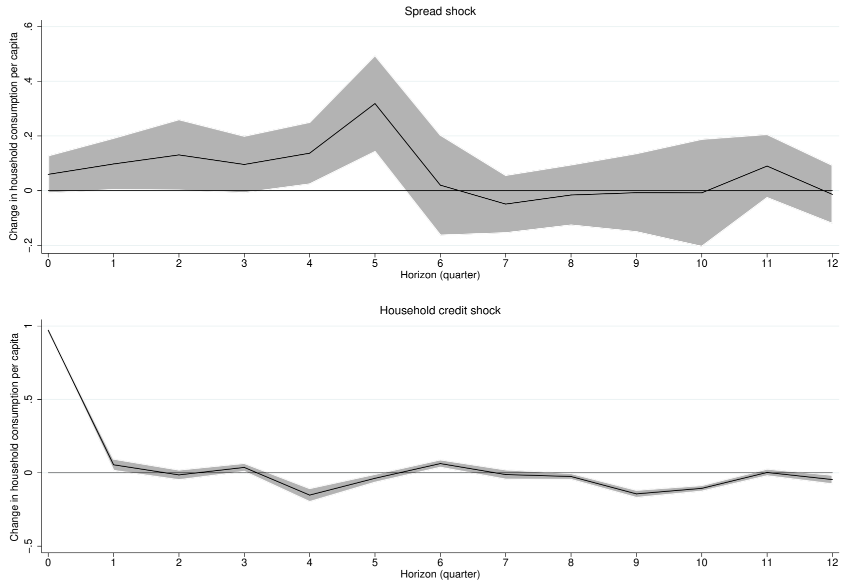
Note: Fixed effects panel regression with horizon-specific intercepts is used to estimate local projections. Non-smoothed credit change and non-standartized shocks are used to analyze impulse responses. Standard errors are clustered by countries.

Figure A.2: Impulse responses for the household consumption spending



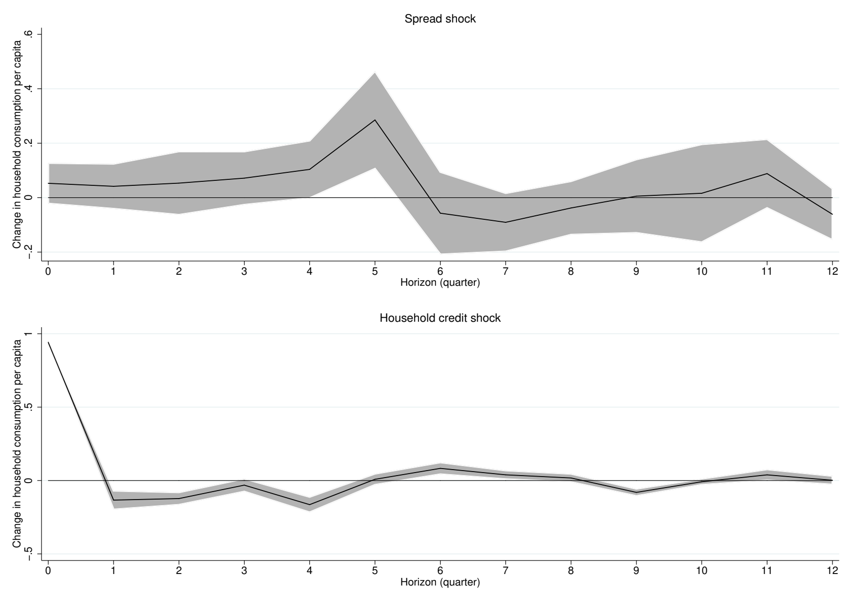
Note: Fixed effects panel regression with horizon-specific intercepts is used to estimate local projections. Non-smoothed credit change is used to analyze impulse responses. Standard errors are clustered by countries.

Figure A.3: Impulse responses for the household consumption spending (with standardized shocks)



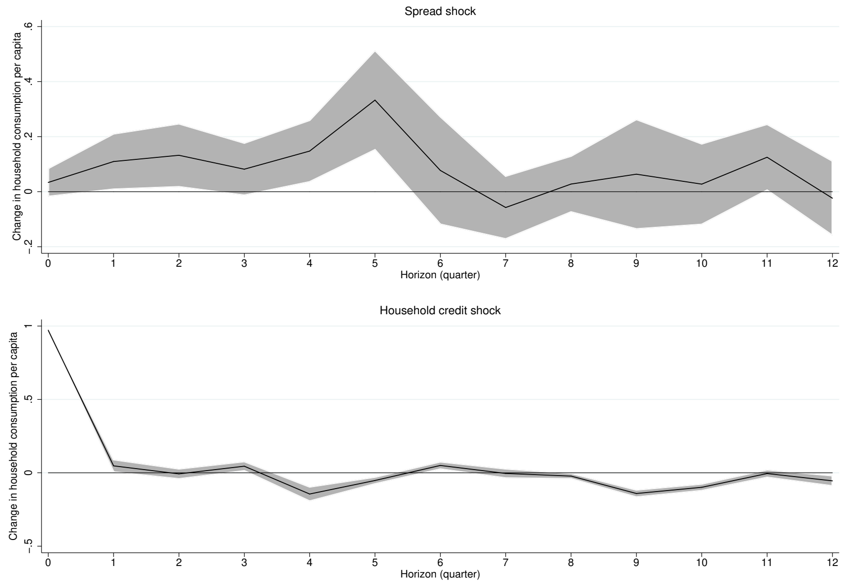
Note: Fixed effects panel regression with horizon-specific intercepts is used to estimate local projections. Additional 4 lags of consumption change are included to analyze impulse responses. Standard errors are clustered by countries.

Figure A.4: Impulse responses for the household consumption spending



Note: Fixed effects panel regression with horizon-specific intercepts is used to estimate local projections. Standard errors are clustered by countries. It also includes additional controls for the time fixed effects.

Figure A.5: Impulse responses for the household consumption spending



Note: Fixed effects panel regression with horizon-specific intercepts and interaction (housing spread and credit shocks) term is used to estimate local projections. Standard errors are clustered by countries.

Figure A.6: Impulse responses for the household consumption spending

A.2 House Price vs. Housing Spread Shocks

Since much of the existing literature has traditionally focused on analyzing house price shocks by modeling changes in house prices while neglecting the dynamics in the rental markets, we adopt a similar approach in this extension. We utilize our identification strategy to model changes in house prices, conducting this analysis twice: once for the United States, which has been the primary focus in many previous papers, and once for a panel of all countries. This dual approach enables us to compare the results for the US and the panel of countries, as well as to observe how our main variable differs from the alternative of using house prices alone.

It might be tempting to conclude that, since house prices are much more volatile than rental rates, there is no significant difference in using either variable in the empirical analysis. However, it's important to note that both variables are non-stationary, as illustrated in Figure 3.1. On the other hand, the spread (or ratio) variable is stationary (see Appendix Table A.1). Therefore, the appropriate comparison should be made either with stationarized house prices (after removing the house price trend) or with the growth rate of housing prices (which becomes a stationary series after first-differencing). However, neither of these comparisons yields the same results as our price-rent spread variable.

The influential literature on housing and macroeconomics has made various choices when it comes to modeling house prices. For example, Attanasio et al. (2011) utilize real (deflated) house prices, which exhibit a permanent component due to a unit root in a VAR setting. On the other hand, Campbell and Cocco (2007) work with log price changes, inducing stationarity in their analysis. Muellbauer and Murphy (1997) incorporate house prices in an ARDL-type framework. More recent works, such as Berger et al. (2018), focus on the price-rent ratio but assume that the rental rate is proportional to house prices, effectively rendering the spread/ratio constant over time. Notably, Favilukis et al. (2017) undertake a careful analysis by considering the deviation of house prices from fundamentals as a key modeling device. However, their analysis is limited to calibration and simulation for the US economy alone, making it challenging for policymakers to apply their findings in a broader cross-country context with institutional differences.[18]

We begin by presenting the results for the United States separately to assess whether our identification strategy yields outcomes consistent with the existing literature. Figure A.7 employs the shock of house price changes and presents the local projections for the United States. Notably, Figure A.7 indicates that the results for the United States differ slightly from the panel projections. It demonstrates that a house price shock in the United States has an instantaneous impact on household consumption, but this effect lasts for only a quarter. These findings align with existing literature, which suggests that house price shocks in the United States typically do not have long-lasting effects (see, for example, Berger et al., 2018).

Appendix Figure A.9 illustrates house price, rental, and spread dynamics for different countries. These figures confirm the intuition that removing the 'trend' by considering the fundamentals delivers the ratio/spread variable with properties that differ from merely looking at house prices. When considering the growth rates, the growth rate of the spread/ratio is defined as the difference between the house and rental growth rates.

Figure A.11 presents results for four different countries: Norway, the US, the UK, and Germany. These countries have relatively long time series, and their institutional settings vary considerably (e.g., they have different home ownership ratios: in Norway, it is quite high; in the US and UK, it is in the middle; and in Germany, it is low). It is evident that the US's immediate reaction is not replicated in other countries (in the UK, it is insignificant at first), in Norway, it is delayed, whereas in Germany, it is negative. Similar to the above, Figure A.12 shows interaction for the same four countries. Hence, this adds another argument: in addition to differences in house price shocks to the ratio/spread variable, there is a clear cross-country heterogeneity aspect, almost necessarily ignored in the theoretical papers due to complexity but crucial for empirical studies and policy implications.

However, there is a notable difference in the response of household consumption to the credit shock. As shown in Figure A.7, we observe a positive effect on consumption in the first quarter, followed by a decline, and then a resurgence in the sixth quarter. This pattern partially aligns with findings in the existing literature (Mian et al., 2017), which suggest an immediate impact of household credit on real economic activity. It's worth noting that the previous literature primarily examines annual data and emphasizes a negative medium-term effect of household credit on economic activity. In the case of the United States, as depicted in Figure A.7, this negative medium-term effect is not immediately evident. However, it's important to consider that the 12-quarter timeframe

[18] It's important to note that one empirical reason why detrended real house prices or growth rates differ from our variable is that our trend represents the fundamental value, allowing us to interpret deviations as components related to bubbles, expectations, or risk premiums. None of the other series provide this interpretation, as they either remove or obscure some of these components, as both price trends and first differences capture all the forces affecting house prices, not only their fundamental value.

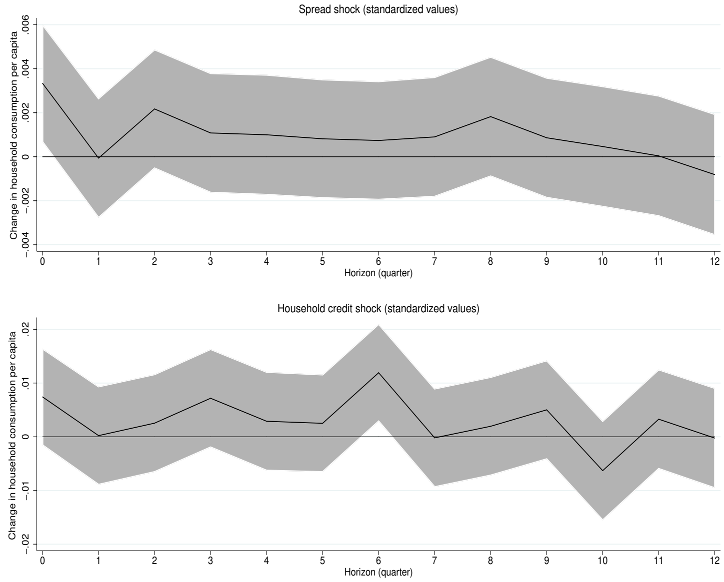
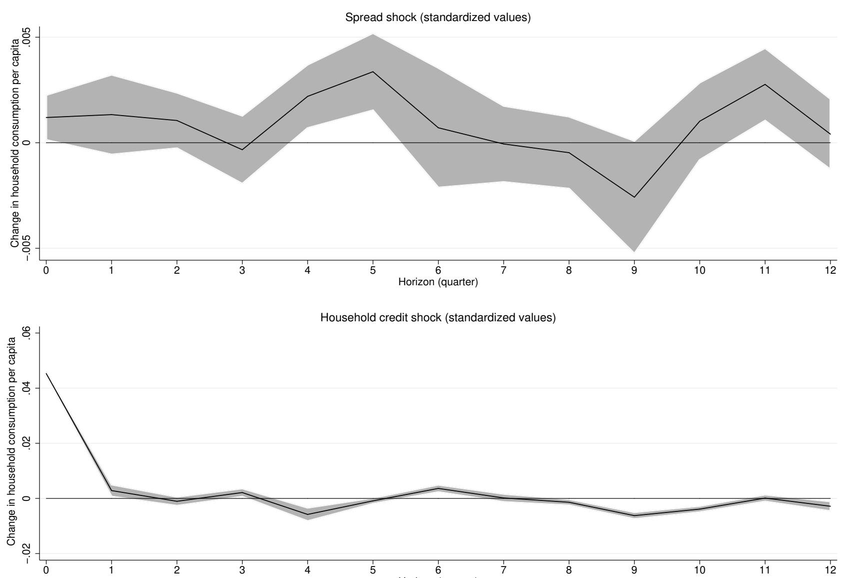


Figure A.7: Impulse responses for the household consumption spending in the United States

might not capture the full scope of medium-term effects. Conversely, the 'boom-bust' medium-term impact of household credit appears to be more pronounced when we analyze the panel results from multiple countries (Figure A.8).



Note: Fixed effects panel regression with horizon-specific intercepts is used to estimate local projections. Standard errors are clustered by countries.

Figure A.8: Impulse responses for the household consumption spending in a full panel of countries

Figure A.9: Growth of House Prices, Rental, and Housing Spread Across Selected Countries

Figure A.10: House Prices, Rental, and Housing Spread Across Selected Countries

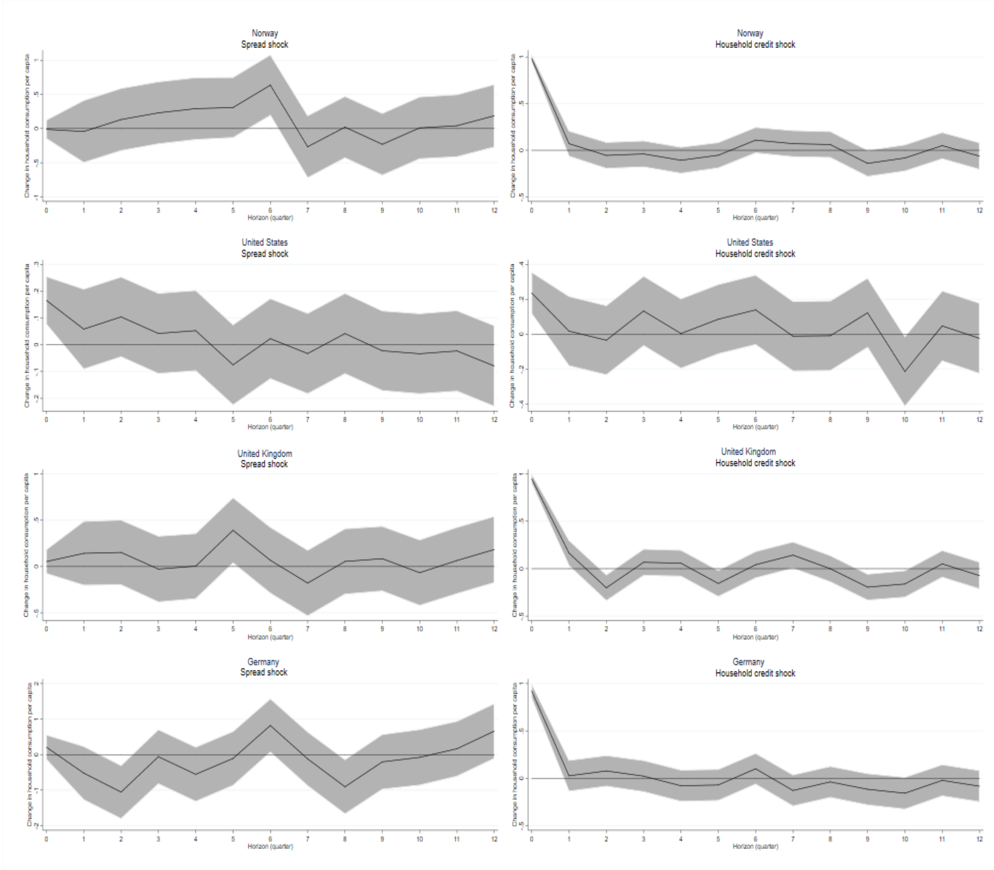


Figure A.11: Impulse responses for the household consumption spending in selected economies (housing spread shock in the left column and credit shock in the right column)

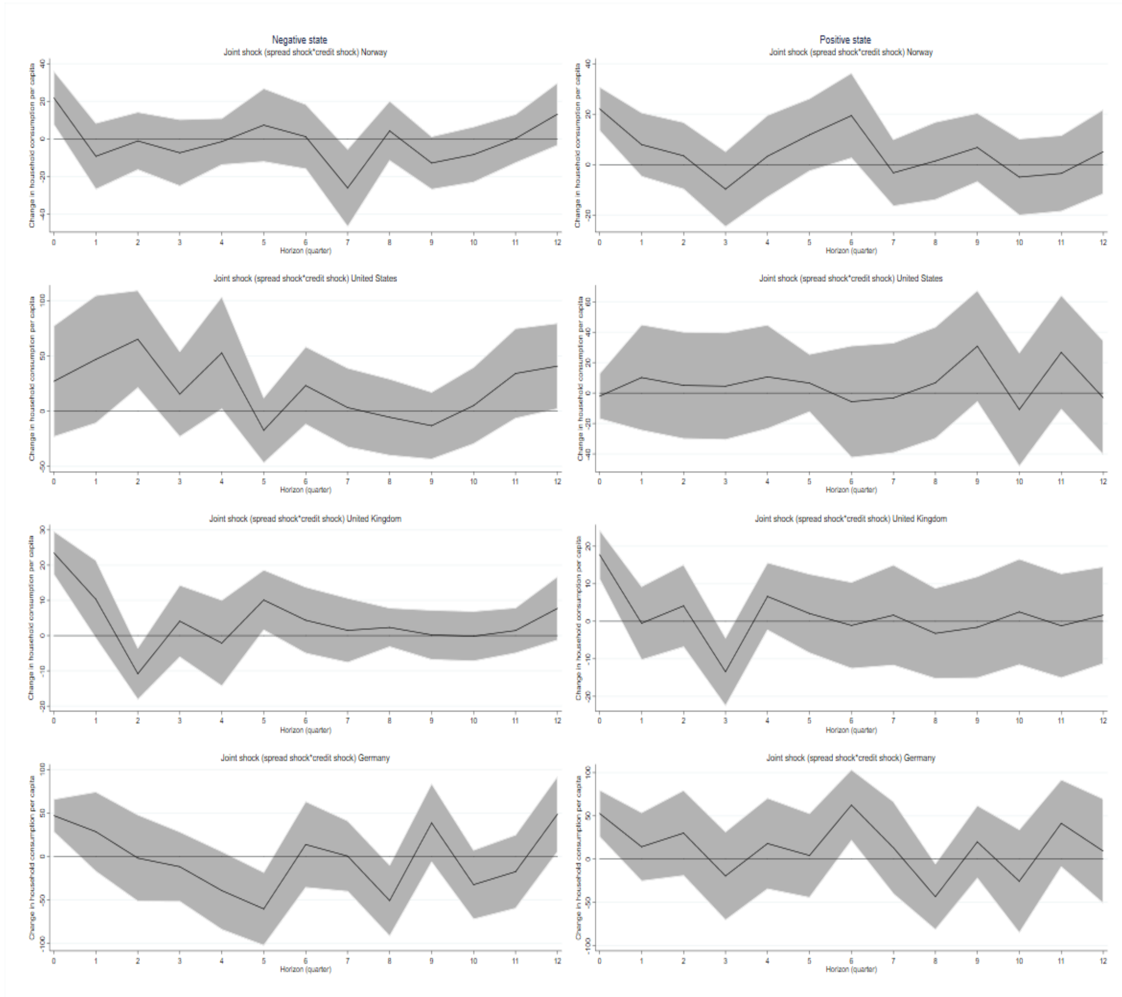


Figure A.12: Impulse responses for the household consumption spending in selected economies by states (a joint housing spread and credit shock)

A.2.1 The House Price-Rent Spread

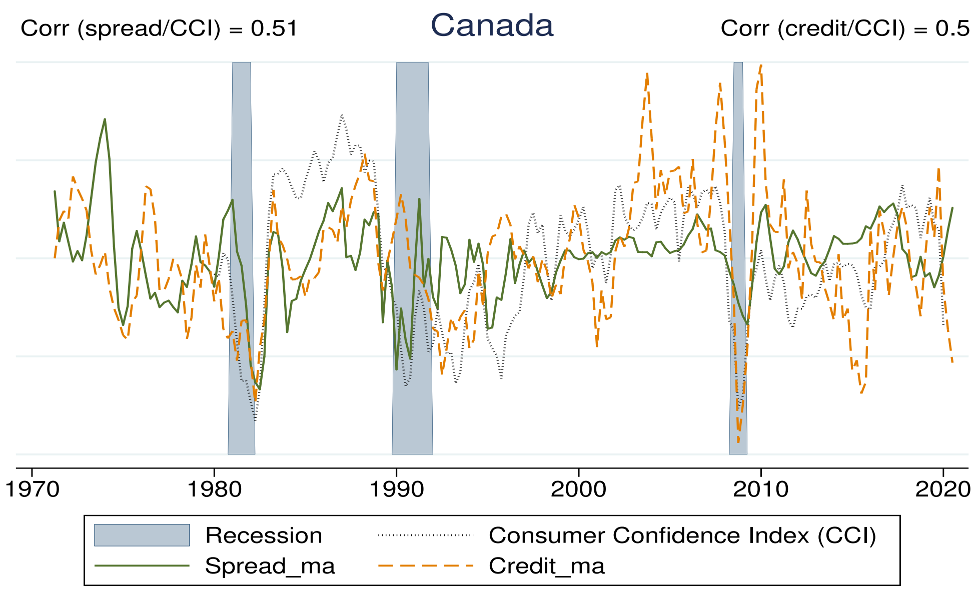


Figure A.13: Recession, Consumer Sentiment Index, Housing Spread, and Credit smoothed (by moving average) variables for Canada

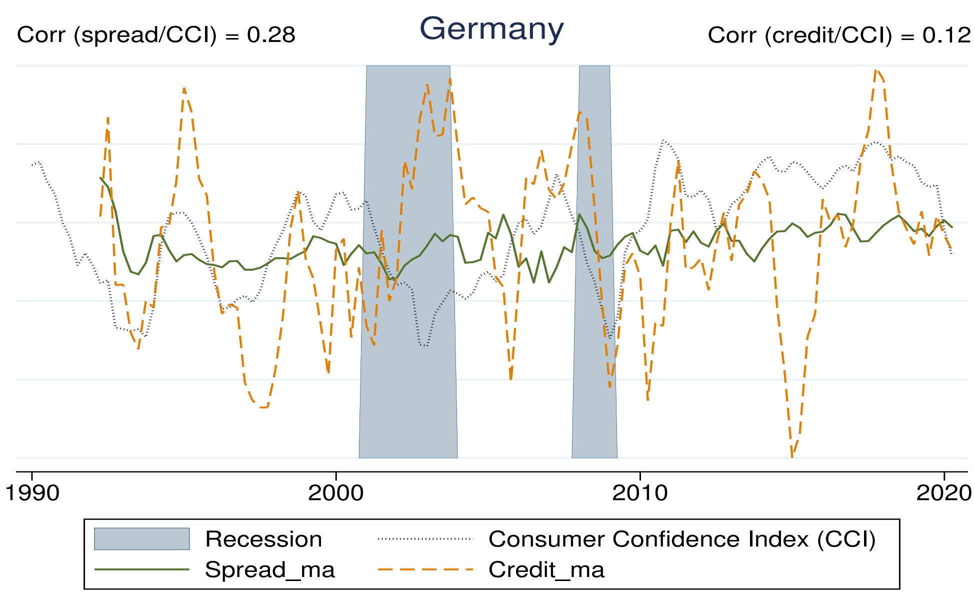


Figure A.14: Recession, Consumer Sentiment Index, Housing Spread, and Credit smoothed (by moving average) variables for Germany

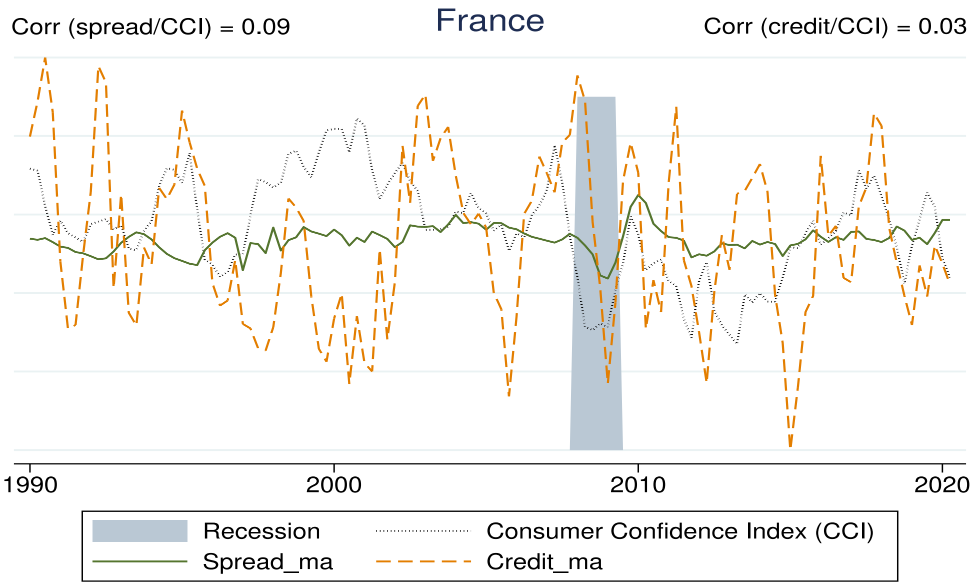


Figure A.15: Recession, Consumer Sentiment Index, Housing Spread, and Credit smoothed (by moving average) variables for France

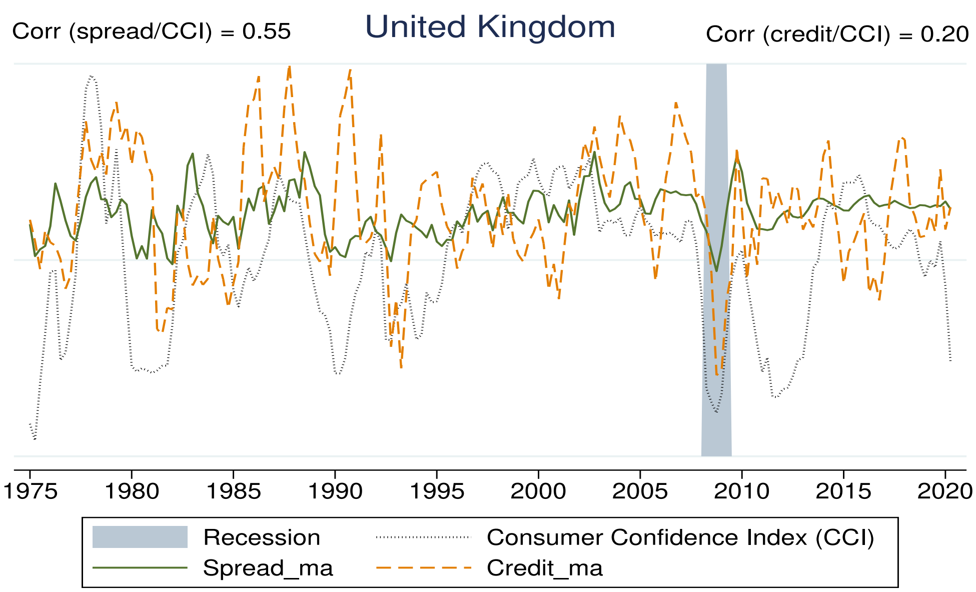


Figure A.16: Recession, Consumer Sentiment Index, Housing Spread, and Credit smoothed (by moving average) variables for UK

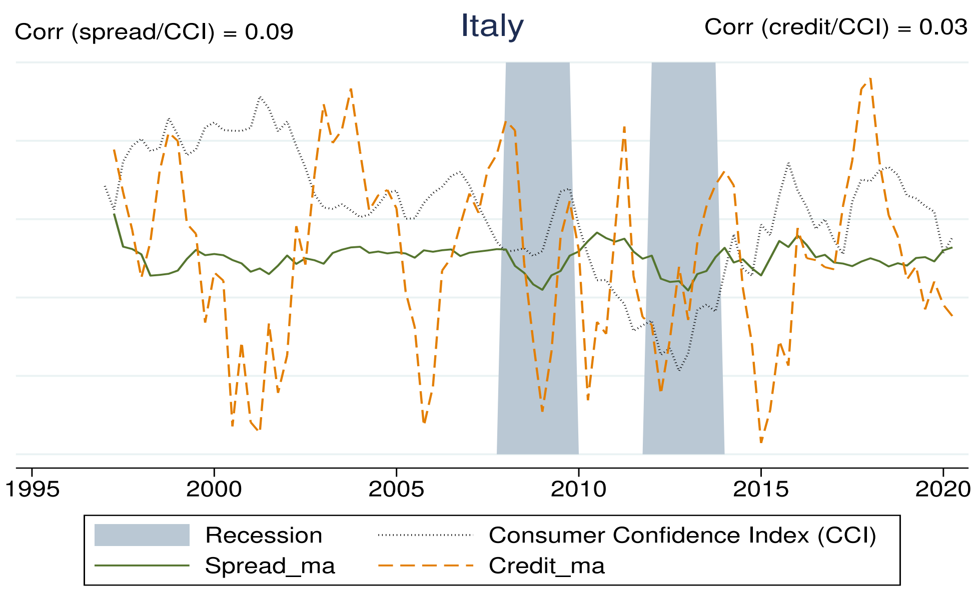


Figure A.17: Recession, Consumer Sentiment Index, Housing Spread, and Credit smoothed (by moving average) variables for Italy

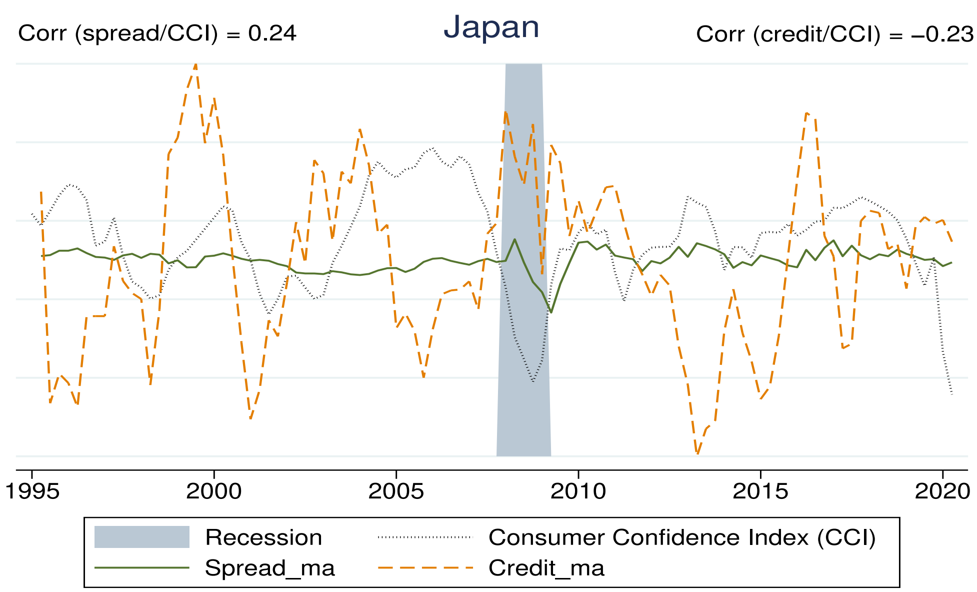
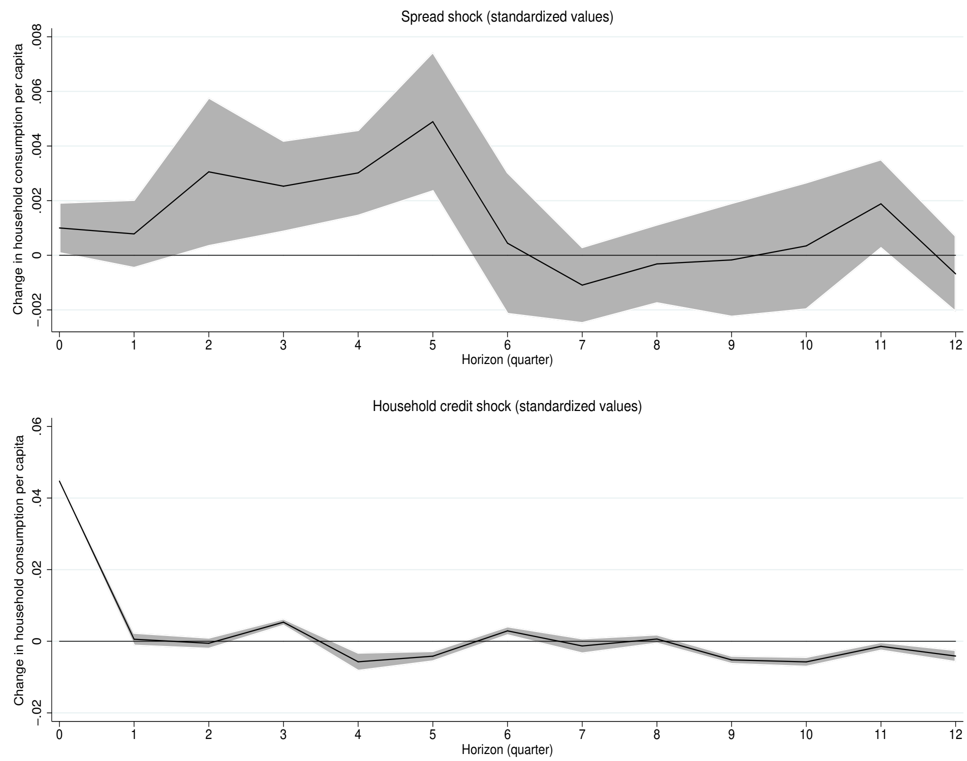


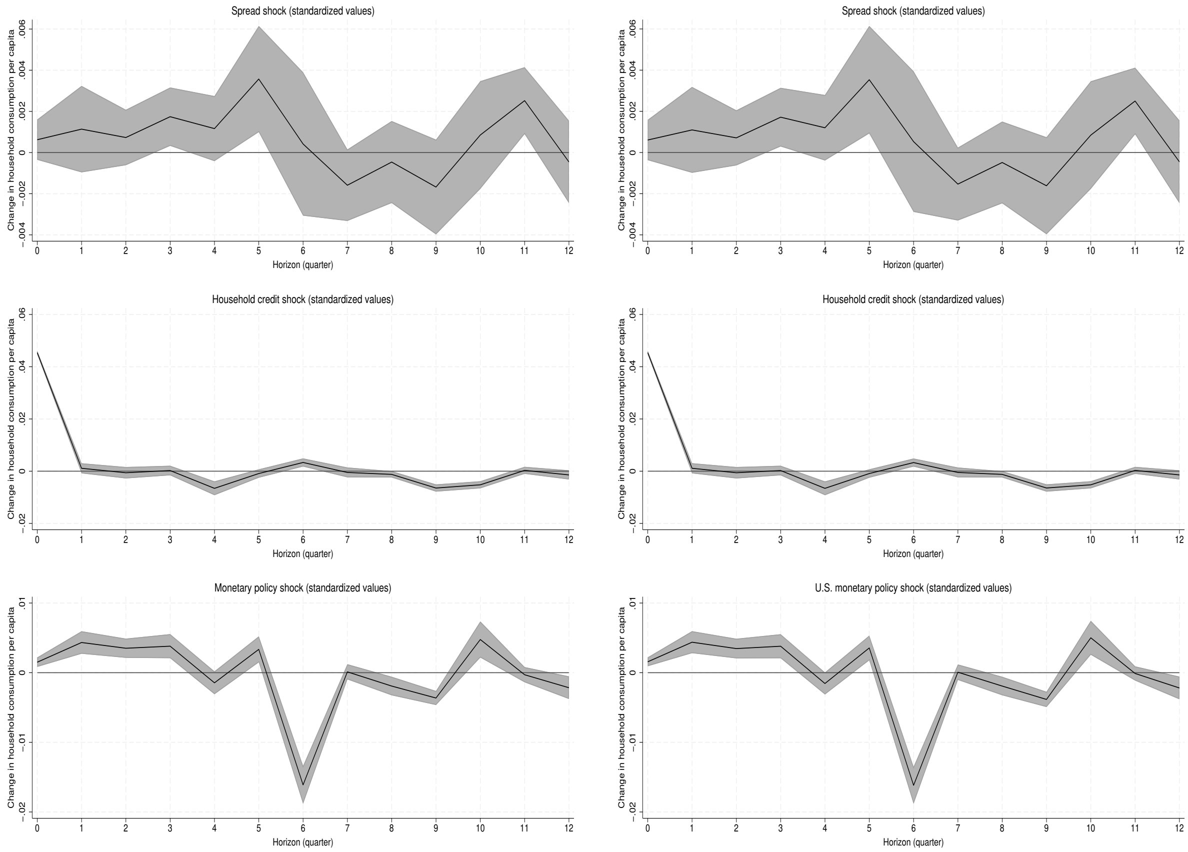
Figure A.18: Recession, Consumer Sentiment Index, Housing Spread, and Credit smoothed (by moving average) variables for Japan

A.2.2 Financial Crisis Effect



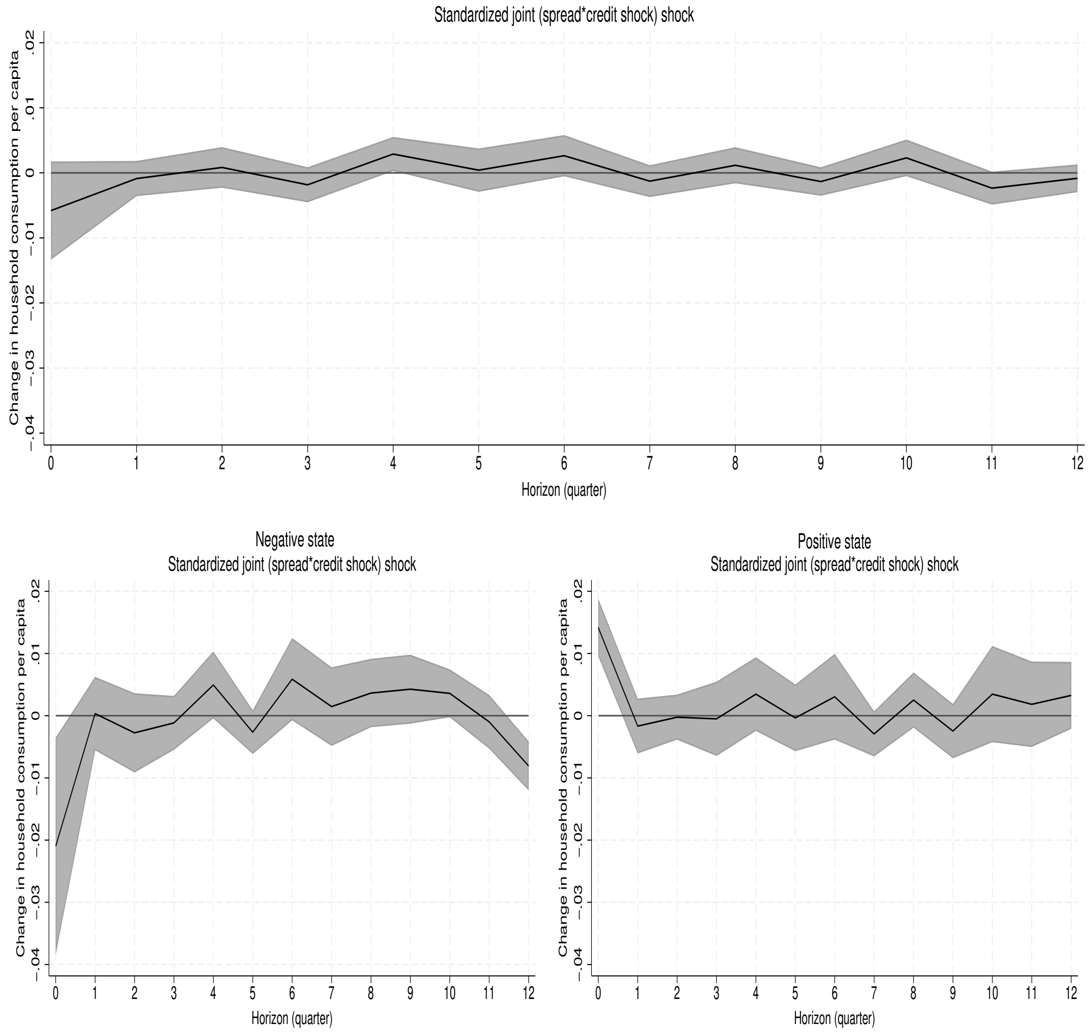
Note: Fixed effects panel regression with horizon-specific intercepts is used to estimate local projections. Standard errors are clustered by countries. Local projections are controlled for recent financial crisis by excluding 2008 and 2009 year observations from estimation.

Figure A.19: Impulse responses for the household consumption spending



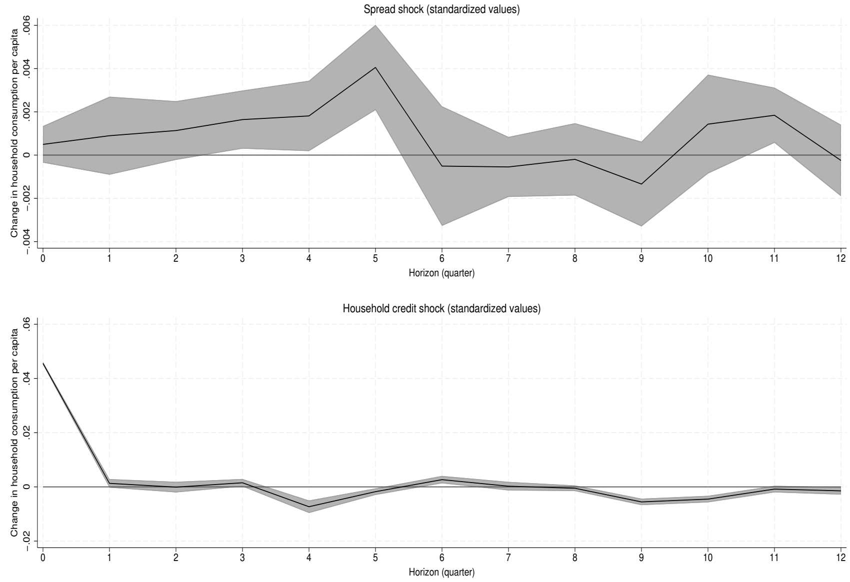
Note: Fixed effects panel regression with horizon-specific intercepts is used to estimate local projections. Standard errors are clustered by countries. The left column identifies results based on country specific long-term interest rates, the right one is built using results with the U.S. long-term interest rates.

Figure A.20: Impulse responses for the household consumption spending (including monetary policy shock)



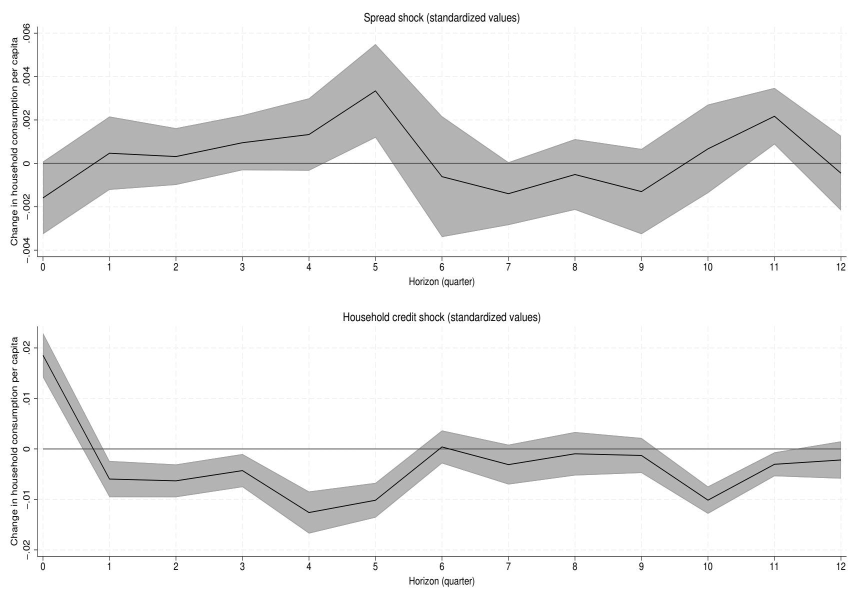
Note: Fixed effects panel regression with horizon-specific intercepts is used to estimate local projections. Standard errors are clustered by countries. Interaction variable is given as a product of spread and credit shocks. First column shows local projections identified for the period when the housing index grows slower than the rental rate index. Alternatively, second column displays results over the positive time periods when the housing index grows faster than the rental rate index. Local projections are controlled for recent financial crisis by excluding 2008 and 2009 year observations from estimation.

Figure A.21: Household consumption responses by states (controlled for financial crisis)



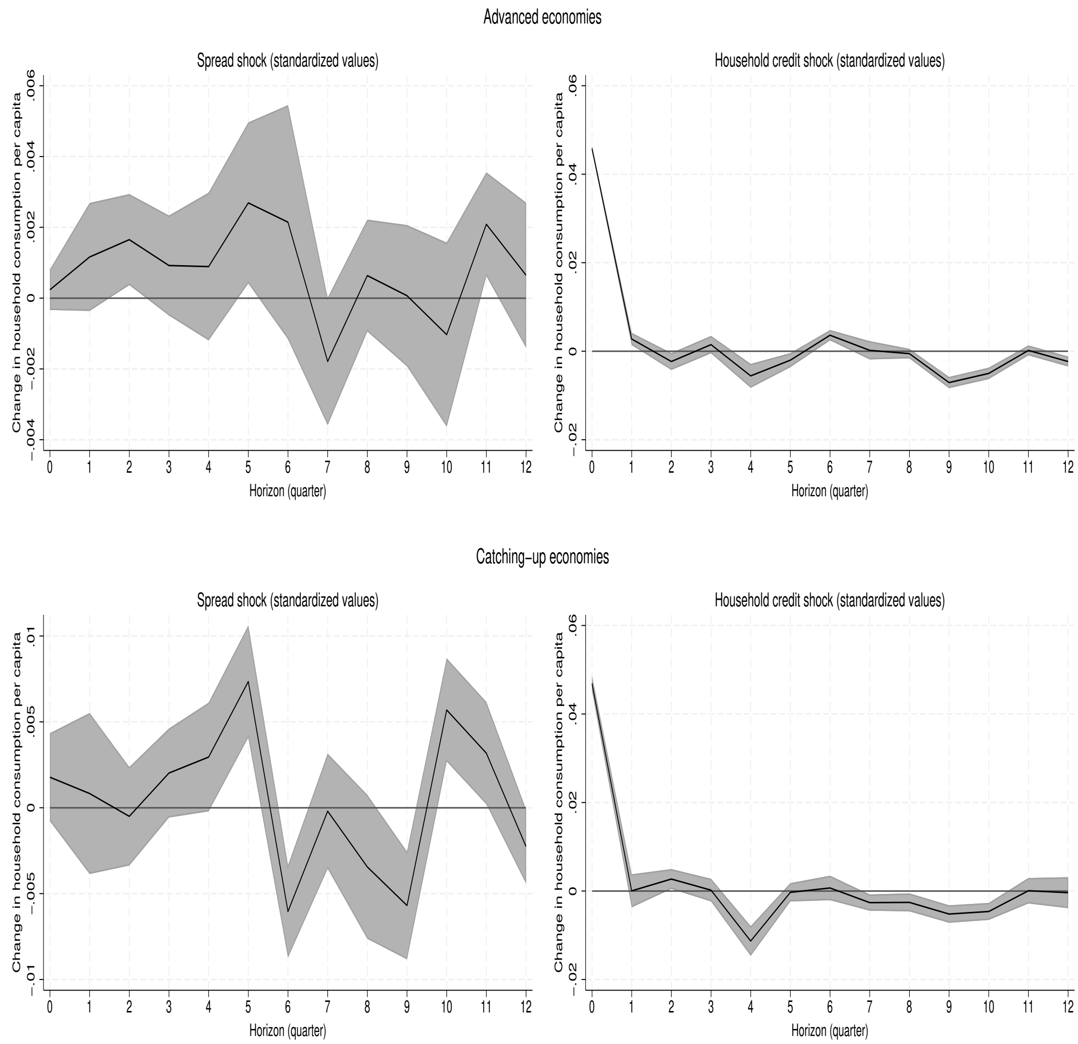
Note: Fixed effects panel regression with horizon-specific intercepts is used to estimate local projections. Standard errors are clustered by countries.

Figure A.22: Household consumption responses by controlling for changes US stock market (global component)



Note: Fixed effects panel regression with horizon-specific intercepts is used to estimate local projections. Standard errors are clustered by countries.

Figure A.23: Household consumption responses by controlling for changes in the principal component between consumption, credit and housing spread variables



Note: Fixed effects panel regression with horizon-specific intercepts is used to estimate local projections. Standard errors are clustered by countries. Countries are separated into subgroups of advanced and catching-up economies by comparing their averages on household consumption per capita. Therefore, we ended up in having 18 countries in the subgroup of advanced economies, and 10 in the subgroup of catching-up economies.

Figure A.24: Household consumption responses by country groups (advanced vs catching-up economies)

A.3 Data Description and Sources

Table A.3: Description of the variables

Variables	Description	Source
Housing index	Nominal house price covers the sale of newly-built and existing dwellings, following the recommendations from RPPI (Residential Property Prices Indices) manual. reference year = 2015	OECD (2020), Housing prices (indicator). doi: 10.1787/63008438-en (Accessed on 28 November 2020)
Renting index	Rent price, nominal value, reference year = 2015	OECD (2020), Housing prices (indicator). doi: 10.1787/63008438-en (Accessed on 28 November 2020)
Final consumption expenditure by households	Quarterly amount of final household consumption in national currency, chained volume estimates, national reference year, quarterly levels, seasonally adjusted (millions of national currency)	OECD (Quarterly National Accounts)
Total household credit	Households and NPISHs total credit in market value (USD), adjusted for breaks (billions of USD)	BIS (Bank of International Settlements), ECB data warehouse
Population	Number of people, in thousands	OECD (Quarterly National Accounts)
Stock index	Country-by-country stock market index	Bloomberg
Short-term interest rate	Three-month money market rates	OECD (Main Economic Indicators)
Long-term interest rate	Government bonds maturing in ten years	OECD (Main Economic Indicators)
Consumer confidence index	Consumer confidence index, amplitude adjusted, long-term average = 100	OECD (Main Economic Indicators)
Exchange rate	Exchange Rates, National/Domestic Currency Per U.S. Dollar, End of Period, Rate	IMF (International Financial Statistics)
Macroeconomic uncertainty	Monthly index	"Measuring Uncertainty" by K. Jurado, S. Ludvigson & S. NG
Monetary policy uncertainty	Monthly index	"Measuring Economic Policy Uncertainty" by Baker, Bloom & Davis
Housing uncertainty	House price index in real terms	International House Price Database (Dallas FED)

All variables are in real terms except for housing and rental indexes.

A.4 Theory

A.4.1 Household's Optimal Plan

The household's optimal plan can be represented as a solution to the following Lagrangian:

$$
\begin{gathered}
\max_{C_s,H_s,B_s} \mathcal{L}_t = \mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t} \left\{ \frac{(C_s)^{1-\nu}}{1-\nu} + \phi \frac{H_s^{1-\nu}}{1-\nu} \right. \\
+\lambda_s \left(B_s + Y_s - C_s - Q_s \left(H_s - H_{s-1}\right) - i_s B_{s-1}\right) \\
\left. +\mu_s \left(\left(1-\chi_s\right) Q_s H_s - B_s\right) \right\} \\
\lambda_s,\, \mu_s \geq 0 \quad s \geq 0, \\
\mu_s \left(\left(1-\chi_s\right) Q_s H_s - B_s\right) = 0 \quad s \geq 0, \\
\mu_s \geq 0,\, \left(1-\chi_s\right) Q_s H_s \geq B_s \quad s \geq 0.
\end{gathered}
$$

Since the resource constraint binds in equilibrium for the locally non-satiated preferences, we imposed that from the outset, abstracting from the associated Kuhn-Tucker conditions. The first order conditions (FOCs) for the time period t yield

$$
\begin{aligned}
\frac{\partial \mathcal{L}_t}{\partial C_t} = 0 \Leftrightarrow & \quad (C_t)^{-\nu} = \lambda_t, \\
\frac{\partial \mathcal{L}_t}{\partial H_t} = 0 \Leftrightarrow & \quad \phi H_t^{-\nu} - \lambda_t Q_t + \mu_t \left(1-\chi\right) Q_t + \mathbb{E}_t \beta \lambda_{t+1} Q_{t+1} = 0, \\
\frac{\partial \mathcal{L}_t}{\partial B_t} = 0 \Leftrightarrow & \quad \lambda_t - \mathbb{E}_t \beta \lambda_{t+1} i_{t+1} - \mu_t = 0.
\end{aligned}
$$

Combining the first two FOCs delivers

$$
H_t^{-\nu} = \frac{1}{\phi} \left\{ (C_t)^{-\nu} Q_t - \mu_t \left(1-\chi\right) Q_t - \mathbb{E}_t \beta \left(C_{t+1}\right)^{-\nu} Q_{t+1} \right\},
$$

which is the equation (2.4), reported in the main text. The shadow price of credit frictions (borrowing constraint) is given by

$$
\begin{aligned}
\mu_t &= \lambda_t - \mathbb{E}_t \beta \lambda_{t+1} i_{t+1} \\
&= (C_t)^{-\nu} \left(1 - \mathbb{E}_t \beta \left(\frac{C_{t+1}}{C_t}\right)^{-\nu} i_{t+1}\right),
\end{aligned}
$$

which is the equation (2.5).

A.4.2 Transversality Condition

Under the no-Ponzi-game condition, we have:

$$
\lim_{\ell \to \infty} \mathbb{E}_t \frac{B_{t+\ell}}{\prod_{\ell=1} i_{t+\ell}} \leq 0.
$$

The condition tells that, in expected value terms, the debt position must grow at a lower rate than the interest rate in the long run. In other words, we exclude the possibility of the house price expectations being driven by having an opportunity to roll the debt into the future without bound. Also, as we are abstracting from the productive side of an economy, notice that the resource constraint can be written as $i_t B_{t-1} = B_t + Y_t - C_t - Q_t \left(H_t - H_{t-1}\right) = B_t + S_t$, where S_t stands for savings, income minus consumption (including housing consumption).

Abstracting from capital as in the main text, write the constraint $i_t B_{t-1} = B_t + Y_t - C_t - Q_t (H_t - H_{t-1}) = B_t + S_t$, where S_t is savings, income minus consumption (including housing consumption) and iterating forward yields

$$\begin{aligned} i_t B_{t-1} &= \tfrac{B_{t+1}}{i_{t+1}} + \tfrac{S_{t+1}}{i_{t+1}} + S_t = \tfrac{B_{t+2}+S_{t+2}}{i_{t+2} i_{t+1}} + \tfrac{S_{t+1}}{i_{t+1}} + S_t \\ &= \ldots = \tfrac{B_{t+\ell}}{\prod_{\ell=1} i_{t+\ell}} + \textstyle\sum_{\ell=1} \tfrac{S_{t+\ell}}{\prod_{\ell=1} i_{t+\ell}} + S_t. \end{aligned}$$

Under the transversality condition, i.e. when a no-Ponzi-game condition is no longer inequality but equality, $\lim_{\ell\to\infty} \mathbb{E}_t \frac{B_{t+\ell}}{\prod_{\ell=1} i_{t+\ell}} = 0$, the forward-iterated expression yields:

$$i_t B_{t-1} = \lim_{\ell\to\infty} \mathbb{E}_t \sum_{\ell=1} \frac{S_{t+\ell}}{\prod_{\ell=1} i_{t+\ell}} + S_t, \tag{A.1}$$

since the first term goes to zero. The initial household's debt position is equal to savings (the difference between income endowment and consumption, including adjustment in the housing consumption) and future expected stream of savings. If a household is initially indebted (so that $B_{t-1} > 0$), then there must be that at least one period with positive savings. Alternatively, if $B_{t-1} < 0$, then at least in principle a household could dissave in all periods. To see that a stock of debt is non-explosive for either, positive or negative, initial position, let us assume away binding borrowing constraint and, in such a case, rule out a possibility for consumption to grow absent stochastic shocks. The required condition is that the subjective discount factor β coincide with the interest rate, $1/i_{t+1}$, so that

$$\lambda_t = \mathbb{E}_t \lambda_{t+1},$$

when $\mu_t = 0$. Notice that credit (borrowing) frictions enable consumption growth even under $\beta i_{t+1} = 1$, if $\mu_t > 0$ (requiring reallocate consumption inter-temporally). Under this assumption, and along the balanced growth path, the equation (A.1) can be written as

$$\begin{aligned} \tfrac{1}{\beta} B &= \tfrac{\beta}{1-\beta} S + S = \tfrac{1}{1-\beta} S, \\ B &= \tfrac{\beta}{1-\beta} S < C, \end{aligned}$$

where C is a finite scalar, $C < \infty$, and $\beta \in (0,1)$. Steady state savings can be positive or negative. In other words, if the starting position for the household is that of net creditor, then it can sustain negative savings perpetually without violating the transversality condition. This result also holds in more general circumstances once the long-run real rate of interest is strictly non-negative.

To summarize, the initial debt position is equal to savings (the difference between income endowment and consumption, including adjustment in the housing consumption) and future expected stream of savings. If a household is initially indebted (so that $B_{t-1} > 0$), then there must be at least one period with positive savings. Alternatively, if $B_{t-1} < 0$, then at least in principle, a household could dissave in all periods. Aggregating into the macroeconomy and introducing investment, we would have obtained a standard result, where savings are adjusted for investment, which equals trade balance in the one-good economy. In other words, the aggregate net (foreign) debt position is equal to the present discounted value of current and future streams of trade surpluses (see, for instance, Uribe and Schmitt-Grohé, 2017). Despite the level of aggregation, we do not need varying preferences β to justify positive or negative savings, which do not violate the transversality condition. For this reason, we stick to the most transparent and succinct environment, which works with one type of households.

A.4.3 Parametric Assumptions

Suppose we assumed, along the lines of Hansen and Singleton (1983), parametric assumptions that interest rates and consumption growth as well as consumption growth and house prices growth were normally distributed, conditional on the information set Ω_t:

$$\left[\begin{array}{c} \triangle \ln C_{t+1} \\ \ln i_{t+1} \end{array}\right] \Bigg| \Omega_t \sim N \left[\left(\begin{array}{c} \mathbb{E}_t \triangle \ln C_{t+1} \\ \mathbb{E}_t \ln i_{t+1} \end{array} \right); \; \left(\begin{array}{cc} \sigma_c^2 & \sigma_{ci} \\ \sigma_{ci} & \sigma_i^2 \end{array} \right) \right] \tag{A.2}$$

and

$$\left[\begin{array}{c} \triangle \ln C_{t+1} \\ \triangle \ln Q_{t+1} \end{array}\right] \Bigg| \Omega_t \sim N \left[\left(\begin{array}{c} \mathbb{E}_t \triangle \ln C_{t+1} \\ \mathbb{E}_t \triangle \ln Q_{t+1} \end{array} \right); \; \left(\begin{array}{cc} \sigma_c^2 & \sigma_{cq} \\ \sigma_{cq} & \sigma_q^2 \end{array} \right) \right]. \tag{A.3}$$

One could also assume trivariate normal distribution, allowing for interest rates be correlated with the growth rate of house prices; we will stick to this simpler environment with two bivariate normal distributions. Let's start with the interest rate and consumption growth:

$$\mathbb{E}_t \left(\frac{C_{t+1}}{C_t}\right)^{-\nu} i_{t+1} = \mathbb{E}_t \exp\left(-\nu \triangle \ln C_{t+1} + \ln i_{t+1}\right),$$

where $\mu_c \equiv \mathbb{E}_t \triangle \ln C_{t+1}, \mu_i \equiv \mathbb{E}_t \ln i_{t+1}$. Using properties of the log-normal distribution, we find that

$$\mathbb{E}_t \exp\left(-\nu \triangle \ln C_{t+1} + \ln i_{t+1}\right) = \exp\left(-\nu\mu_c + \mu_i + \frac{1}{2}\nu^2\sigma_c^2 + \frac{1}{2}\sigma_i^2 - \nu\sigma_{ci}\right).$$

Using (2.13) and (2.5), we have

$$\begin{aligned} 1 - (1-\chi)^{-1}\left(1 - \left(\tfrac{R_t^H + \mathcal{S}_t}{Q_t}\right)\right) &= \beta \mathbb{E}_t \left(\tfrac{C_{t+1}}{C_t}\right)^{-\nu} i_{t+1}, \\ 1 - (1-\chi)^{-1}\left(1 - \tfrac{R_t^H}{Q_t} - \beta \mathbb{E}_t \left(\tfrac{C_{t+1}}{C_t}\right)^{-\nu} \tfrac{Q_{t+1}}{Q_t}\right) &= \beta \mathbb{E}_t \left(\tfrac{C_{t+1}}{C_t}\right)^{-\nu} i_{t+1}. \end{aligned} \tag{A.4}$$

Following the same logic for the house prices,

$$\mathbb{E}_t \left(\frac{C_{t+1}}{C_t}\right)^{-\nu} \frac{Q_{t+1}}{Q_t} = \mathbb{E}_t \exp\left(-\nu \triangle \ln C_{t+1} + \triangle \ln Q_{t+1}\right),$$

where $\mu_c \equiv \mathbb{E}_t \triangle \ln C_{t+1}, \mu_q \equiv \mathbb{E}_t \triangle \ln Q_{t+1}$. Using properties of the log-normal distribution, we find that

$$\mathbb{E}_t \exp\left(-\nu \triangle \ln C_{t+1} + \triangle \ln Q_{t+1}\right) = \exp\left(-\nu\mu_c + \mu_q + \frac{1}{2}\nu^2\sigma_c^2 + \frac{1}{2}\sigma_q^2 - \nu\sigma_{cq}\right).$$

Returning back to equations (A.4), we obtain

$$
\begin{gathered}
1-(1-\chi)^{-1}+(1-\chi)^{-1}\tfrac{R_t^H}{Q_t}=\beta\mathbb{E}_t\left(\tfrac{C_{t+1}}{C_t}\right)^{-\nu}(1-\chi)^{-1}\left((1-\chi)\,i_{t+1}-\tfrac{Q_{t+1}}{Q_t}\right),\\
\beta^{-1}\left(\tfrac{R_t^H}{Q_t}-\chi\right)=(1-\chi)\,\mathbb{E}_t\left(\tfrac{C_{t+1}}{C_t}\right)^{-\nu}i_{t+1}-\mathbb{E}_t\left(\tfrac{C_{t+1}}{C_t}\right)^{-\nu}\tfrac{Q_{t+1}}{Q_t}\\
=(1-\chi)\exp\left(-\nu\mu_c+\mu_i+\tfrac{1}{2}\nu^2\sigma_c^2+\tfrac{1}{2}\sigma_i^2-\nu\sigma_{ci}\right)-\exp\left(-\nu\mu_c+\mu_Q+\tfrac{1}{2}\nu^2\sigma_c^2+\tfrac{1}{2}\sigma_Q^2-\nu\sigma_{cQ}\right)\\
=\exp\left(-\nu\mu_c+\tfrac{1}{2}\nu^2\sigma_c^2\right)\left((1-\chi)\,e\left(\mu_i+\tfrac{1}{2}\sigma_i^2-\nu\sigma_{ci}\right)-\exp\left(\mu_Q+\tfrac{1}{2}\sigma_Q^2-\nu\sigma_{cQ}\right)\right).
\end{gathered}
$$

Taking logs and rearranging (when $\frac{R_t^H}{Q_t}-\chi>0$ and $((1-\chi)\,Q_t)\,\mathbb{E}_t\left(C_{t+1}\right)^{-\nu}i_{t+1}-\mathbb{E}_t\left(C_{t+1}\right)^{-\nu}Q_{t+1}>0$):

$$
\begin{gathered}
\nu\mathbb{E}_t\triangle\ln C_{t+1}=\ln\beta-\ln\left(\tfrac{R_t^H}{Q_t}-\chi\right)+\tfrac{1}{2}\nu^2\sigma_c^2\\
+\ln\left[(1-\chi)\exp\left(\mathbb{E}_t\ln i_{t+1}+\tfrac{1}{2}\sigma_i^2-\nu\sigma_{ci}\right)-\exp\left(\mathbb{E}_t\triangle\ln Q_{t+1}+\tfrac{1}{2}\sigma_Q^2-\nu\sigma_{cQ}\right)\right],\\
\nu\mathbb{E}_t\triangle\ln C_{t+1}=\ln\beta-\ln\left(\tfrac{R_t^H-\chi Q_t}{Q_t}\right)+\tfrac{1}{2}\nu^2\sigma_c^2\\
+\ln\Big[(1-\chi)\exp\left(\mathbb{E}_t\ln i_{t+1}+\tfrac{1}{2}\sigma_i^2-\nu\sigma_{ci}+\tfrac{1}{2}\nu^2\sigma_c^2-\tfrac{1}{2}\nu^2\sigma_c^2\right)\\
-\exp\left(\mathbb{E}_t\triangle\ln Q_{t+1}+\tfrac{1}{2}\sigma_Q^2-\nu\sigma_{cQ}+\tfrac{1}{2}\nu^2\sigma_c^2-\tfrac{1}{2}\nu^2\sigma_c^2\right)\Big]=\ln\beta-\ln\left(\tfrac{R_t^H-\chi Q_t}{Q_t}\right)+\tfrac{1}{2}\nu^2\sigma_c^2\\
+\ln\Big[\exp\left(-\tfrac{1}{2}\nu^2\sigma_c^2\right)\Big[(1-\chi)\exp\left(\mathbb{E}_t\ln i_{t+1}+\tfrac{1}{2}\sigma_i^2-\nu\sigma_{ci}+\tfrac{1}{2}\nu^2\sigma_c^2\right)\\
-\exp\left(\mathbb{E}_t\triangle\ln Q_{t+1}+\tfrac{1}{2}\sigma_Q^2-\nu\sigma_{cQ}+\tfrac{1}{2}\nu^2\sigma_c^2\right)\Big]\Big]=\ln\beta-\ln\left(\tfrac{R_t^H-\chi Q_t}{Q_t}\right)\\
+\ln\Big[(1-\chi)\exp\left(\mathbb{E}_t\ln i_{t+1}+\tfrac{\nu^2}{2}\mathrm{Var}_t\left(\triangle\ln C_{t+1}-\tfrac{1}{\nu}\ln i_{t+1}\right)\right)\\
-\exp\left(\mathbb{E}_t\triangle\ln Q_{t+1}+\tfrac{\nu^2}{2}\mathrm{Var}_t\left(\triangle\ln C_{t+1}-\tfrac{1}{\nu}\ln\triangle\ln Q_{t+1}\right)\right)\Big].
\end{gathered}
$$

Dividing both sides by ν:

$$
\begin{gathered}
\mathbb{E}_t\triangle\ln C_{t+1}=\nu^{-1}\ln\beta-\nu^{-1}\ln\left(\tfrac{R_t^H-\chi Q_t}{Q_t}\right)\\
+\nu^{-1}\ln\Big[(1-\chi)\exp\left(\mathbb{E}_t\ln i_{t+1}+\tfrac{\nu^2}{2}\mathrm{Var}_t\left(\triangle\ln C_{t+1}-\tfrac{1}{\nu}\ln i_{t+1}\right)\right)\\
-\exp\left(\mathbb{E}_t\triangle\ln Q_{t+1}+\tfrac{\nu^2}{2}\mathrm{Var}_t\left(\triangle\ln C_{t+1}-\tfrac{1}{\nu}\ln\triangle\ln Q_{t+1}\right)\right)\Big].
\end{gathered}
$$

Once $\frac{R_t^H}{Q_t}-\chi<0$ and $((1-\chi)\,Q_t)\,\mathbb{E}_t\left(C_{t+1}\right)^{-\nu}i_{t+1}-\mathbb{E}_t\left(C_{t+1}\right)^{-\nu}Q_{t+1}<0$, then

$$
\begin{gathered}
\mathbb{E}_t\triangle\ln C_{t+1}=\nu^{-1}\ln\beta-\nu^{-1}\ln\left(\tfrac{\chi Q_t-R_t^H}{Q_t}\right)\\
+\nu^{-1}\ln\Big[\exp\left(\mathbb{E}_t\triangle\ln Q_{t+1}+\tfrac{\nu^2}{2}\mathrm{Var}_t\left(\triangle\ln C_{t+1}-\tfrac{1}{\nu}\ln\triangle\ln Q_{t+1}\right)\right)\\
-(1-\chi)\exp\left(\mathbb{E}_t\ln i_{t+1}+\tfrac{\nu^2}{2}\mathrm{Var}_t\left(\triangle\ln C_{t+1}-\tfrac{1}{\nu}\ln i_{t+1}\right)\right)\Big].
\end{gathered}
$$

Therefore, consumption growth, unlike standard applications with precautionary savings, depends on the difference between down-payment and rental rates, $\left|\chi Q_t-R_t^H\right|$, and thus also on the spread, $\mathcal{S}_t$, as well as a nonlinear function, capturing long-term averages of house price growth rates and interest rates, the conditional variability of consumption growth rate, the house prices growth rate and the interest rate. The latter ingredients capture uncertainty regarding all forward-looking variables, which can be further extended to the uncertainty of the US interest rate and exchange rates, a path we took in the working paper version assuming uncovered interest rate parity. Refer to the main text (Section 5.2) for empirical results when uncertainty measures to capture macroeconomic (consumption), monetary policy (interest rate), and housing are included in the baseline model.